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THE IMPROVEMENT OF PADDY VARIETIES.

For the past five years, the Department of Agriculture has been engaged upon the isolation of high-yielding pure lines of paddy from the mixtures which are generally cultivated by growers. This work has been concentrated at the Experiment Stations at Anuradhapura and Peradeniya and a fair measure of success has been obtained. A number of pure lines of paddy, both of long and short "ages" have been isolated and tested for a number of crops.

Results of the work in hand have from time to time been presented to the Board of Agriculture and published in the *Tropical Agriculturist* and in the Annual Reports of the Department of Agriculture. There are now in the possession of the Department a number of strains which are capable of producing yields at Anuradhapura Experiment Station greatly in excess of the average paddies.

The next step after the isolation of the pure lines by the Economic Botanist is the testing of the different promising strains in the various rice-growing districts of the colony. This has been begun and the results of the past two years' work have varied. Whereas one variety at Anuradhapura has matured within a certain period, a totally different period has been required in another district. Sometimes this period has been extended and in other instances it has been considerably shortened. The reasons for this behaviour have not as yet been studied in detail but there are certain lines of investigation which suggest themselves. In other centres, certain strains have proved to be well suited to the requirements and an

account is given in our present issue of a pure line strain of paddy which has proved successful in the Central Province and which is now being extended as rapidly as possible. There are other instances in which strains appear to be suited to particular localities, but the time has come for the Department of Agriculture to review its past experiences and to extend its work in the testing of varieties and the distribution of seed of the best types.

No variety can be recommended with any degree of confidence to a grower until it has been tested in his district, and it now appears to be necessary to consider the necessity of providing a number of small paddy-growing stations at which these new varieties can be tested. A beginning has been made on those minor experiment stations where paddy land exists, but an extension of the number will have to take place if the country is to derive its full benefit from the pure-line strains which have already been isolated.

Further varieties are also in the course of selection and stations will be required in the areas from which these varieties were originally obtained in order that the pure-lines secured from them may be tested.

In the large deltaic rice-growing areas of India and Burma where climatic and soil conditions are very uniform it is possible for a single type to be suited for cultivation over large areas. In Ceylon, the conditions are totally different. The soil and climatic conditions vary from district to district and a number of types will be required. It is necessary that these be thoroughly tested before seed is distributed to cultivators.

The experience of growers of these new types of paddy which has been found to be suited to any locality show what may be expected in the way of increased yields, and it is anticipated that growers will appreciate the opening of a number of stations solely for experimental work with paddy. In the past the Department has endeavoured to rely upon growers to test its varieties of paddy but the experience of the past two years indicates that a further extension of the experiment station method of testing is necessary.

PADDY.

SOME RESULTS IN PADDY SELECTION.

THE HISTORY OF B-12 STRAIN.

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The Department of Agriculture, Ceylon, began to devote special attention to the isolation and breeding of improved strains of local paddy varieties in 1919, and several well-bearing types are now ready for distribution to cultivators. As the process of such selection work entails a great deal of specialised work, and is usually beyond the scope of the cultivator, the following account, which traces one strain from the arrival in the laboratory of the first packet of mixed seed to its success in a cultivator's field, will probably be of interest.

The strain chosen for description is now being grown in Harispattu where it is considered to be superior in many respects to the former local type of *hatial*, which it is gradually supplanting. Although, as will be seen, this strain was selected from seed that was known as *kohumawi*, it has been named *Peradeniya hatial* by the Harispattu cultivators.

The steps of its progress will be described in two sections : namely, in the laboratory and on the experiment station fields ; and in the fields at Harispattu on privately owned land.

Section 1. Work in the Laboratory and at the Experiment Station, Anuradhapura.

In August, 1919, the Director of Agriculture obtained a large number of samples of different paddy varieties from Headmen (through G. A.s and A. G. A.s), and Agricultural Instructors (through the Ceylon Agricultural Society). Of these we are presently concerned with 105 varieties reported as of 6 to 7 months' duration of growth. The details supplied by the sender of the type under consideration were,

"Varietal name Kohumawi.
From R. M. Yatinuwara, Kandy District,
Age 7½ months."

In the laboratory register, the type was given the number 33 and included with others from the C. P. As the Economic Botanist had not yet arrived in Ceylon on first appointment, nothing in the nature of a botanical description was attempted until he should be able to examine the growing crop. After an initial hand-picking to remove grains that were obviously foreign to the main bulk, samples were sent to Anuradhapura with instructions for sowing 4,000 seeds of each variety in nursery beds, and later on for transplanting the seedlings 6 in. apart in two beds each 4 ft. wide and 1 chain long. Sowing was done on 1st October, 1919.

A test of germination power gave only 30-35% good seed. This was probably due to bad storage. The sample was very mixed, being typically fully awned, with a husk-colour varying from light to dark brown, with

or without a striped effect due to darker colouring in the furrows. These facts will be discussed later, but are given here to emphasise the point that much of the seed obtained showed the effects of bad storage, wet harvest, etc.; and that, although a name was commonly used, it was possible in the laboratory to sort out several quite different types, any or none of which might have been the real named one. It is interesting to note, in passing, that one strain of extreme character, chosen from the same sample as that under review was refused a trial in its original district, as it was said to be too much unlike the original stock bearing the same name.

The plants at Anuradhapura eared on February 10th, 1920, and were harvested on March 23rd. Each plant was dug up with its roots, dried, and the plants of each variety roughly sorted into groups, viz.: awned, awnless, white, black, red, in single, and in combination viz.: red awned, black awnless, etc. They were further analysed for tillering, and the *best plant or plants of each tiller class reserved for future work.* The following records of variety 33 were noted in the field book :—

Red (husk), awned : black, awned : : 276 : 61.

Tiller mode, 3. (*i.e.* the tiller-class containing the largest number of individuals).

Fine tall plants. 51 seed packets chosen (seeds of one plant only in each packet).

Height of four plants chosen at random, 74 in., 65 in., 74 in., 65 in.

No. of Tillers.	No. of Plants.	No. of Plants Selected.	
1	52	0	
2	54	0	
3	79	12	
4	59	14	*Notes.* An awned
5	(23)	(8)	variety. Very abundant.
6	4	2	
7	4	4	
8	1	1	
	n=276	Total 41	Selected for further trial.

The strain now known as B-12 came from the 6th plant of tiller class 5, and appears in the records of this harvest as "33/5'6—four ears. Husk colour dark brown. Awnless." It will be noticed at once that it differs from the main sample in the *absence of awns.*

Particular care was taken in sowing, as it was necessary to eliminate all chance of a stray seed of paddy already in the ground sprouting and appearing amongst the carefully selected strain. The progeny of a single plant selection of a self-pollinated plant, is known to the plant breeder as a Pure Line, Pedigree Strain, etc. This season marked the beginning of a series of pure line cultures. Thirty such were included of variety 33, and each was allotted a number. To save confusion in labelling, when one number followed another, the varieties chosen for re-trial were registered under a scheme of a letter followed by a number. Thus the thirty strains of variety 33 were indexed as B-1, B-2, etc. to B-30. From this season onwards, B-12 may be recognised under its present name.

Accordingly, seeds were spaced at intervals 2 in. by 2 in., so that any plant appearing at irregular intervals could immediately be noted and pulled out. This entailed a great deal of work and could not be carried out for all the strains. B-12 was sown in this manner in October 10th, 1920. Transplanting began on November 10th. Each strain was planted in beds according to the number of seedlings available. The following particulars were noted in the progress report :—Seeds sprouted 148. Not sprouted 141. Total sown 289. Germination 50%. Seeds spaced in the nursery at 2 in. × 2 in. Seedlings transplanted 196. 179 survived on inspection 5 days later. Height on December 1st, 24 in. Tillering well. Flowered 20th January. 1921. Harvested 5th April, 1921.

On an inspection on 18th February, 1921, B-12 was noted as amongst the "Exceptional" class, desirable for further trial. The plots were rogued (*i.e.* any plants appearing untrue to type were pulled out), and the outer two rows harvested separately. The field book further states :—

Leaf sheath 12 in.
,, blade 24·3 in. (2nd leaf).
Panicle 11·8 in. drooping
Height of plants 60 in.
Grains brown, awnless.
Rice full red seed coat.
0·25 quarts of blackish-husked paddy as a mixture.
Number of outer plants 93.
Number of inner plants 90.
Volume of grain, outer plants 6·0 measures.
,, inner plants 3·5 measures.

INFLORESCENCE.

Peduncle green and almost straight.
Rachis green and slightly curved.
Rachilla green, comma, flat.

FLOWER.

Pedicel ordinary.
1st glume green in young stage.
2nd ,, ,,
Lemma pronounced, blackening in the furrows towards the apex.
Palea dark brown towards the apex.
Awns nil.

FRUIT.

Slightly convex.

Roughly computed, the yield per 100 plants was equivalent to 93 bushels per acre, but the figure must not be relied upon, as the error in conversion from yield of small plot to yield per acre is necessarily large.

For the season 1921-22, it was decided to try the strains on a larger scale. One quart of each, taken from the inner rows of the previous season to avoid contamination by foreign pollination, was soaked on 9th October, 1921, germinated in plantain leaf, and sown on 16th September in a nursery strip measuring 9 ft. by 50 ft., leaving 3 ft. between contiguous plots. Germination tests, in uncovered petri dishes, were made on 150 seeds of each strain, which, after being soaked for 48 hours, were put on damp ticking. The following particulars are given of B-12 :—

Soaked 9/10/ January, 1922. Germination first noted 15/1. Maximum germination 142 seeds on 20/1. Progress on 15/1 and subsequent days 78-113-132-137-138-142. Germination 94·7% which shows a distinct improvement over the 30-35% of the original sample.

It will be noted that germination started much later under laboratory conditions in an open dish, than when submitted to pressure in a heap, as in practice.

Transplanting began on October 11th, seedlings being planted 6" x 6" in plots of 4 ft. 6 in. by 40 ft. 6in. (81 rows of 9 plants). Eight repetition plots of each strain were laid down, one on each day until completed. Differences due to soil variations should thus be minimised.

It was decided to fill up gaps left by dead plants, in order to make the comparison more exact. Each gap was denoted by a cross on squared paper for purposes of comparison in the laboratory, and surplus seedlings from the nurseries were supplied to the vacancies. The percentage stand of the eight plots of B-12 was found to be:—
97·25%: 96·16%: 95·60%: 99·86%: 94·50%: 91·10%: 98·63%: 98·40%: Average 96·46%.

It is a general failing among Ceylon paddies that they lodge, or fall over, at some period before harvest, and this causes great loss owing, chiefly, to wetting of the grain, and increased shedding during harvest, which is rendered difficult and is often incomplete as a consequence. Counts were, therefore, made on this crop on two dates, one on February 3rd, 1922, another four days later after two days of heavy, beating rain. Each repetition was treated separately and allotted 1 mark if all standing, and 0 marks if all laid. The results noted for B-12 were:—

Feb. 3rd. $1+1+1+1+0+1+0\frac{3}{4}+1+1=6\frac{3}{4}=84\%$ stand.
Feb. 7th. $1+1+1+1+0+0\frac{3}{4}+0\frac{1}{2}+1+1=6\frac{1}{4}=78\%$ "

Considering all the pure line strains of variety 33 as a group, and comparing the figures obtained from similar groups, the 33 group stood third out of 23 on Feb. 3rd, and second in order of merit on Feb. 7th.

The following notes, taken on different dates, are interesting :—

December 17, 1921. Stooling well, 3–6 tillers on average plant. Leaves show slight browning at tips. Leaf blade slender to medium in breadth, and light green in colour. General habit of plant, upright.

Feb. 5, 1922. General habit of plant, bunching *i.e.* tillers all growing up together in a bunch and not spreading. Stems of medium stoutness, but above average. Amount of leaf, above average. Grains without awns. Flag leaf erect. General height of plants, 69 in.

The plants of each plot were harvested in two bundles for ease in carrying, and labels were affixed for identification thus:—

Field 17 B-12/2 15·3·22	B-12/17/2 15·3·22	*i.e.* 2nd bundle of B-12 from field 17 harvested on 15·3·22.

The double labelling was necessary as rats had already started to destroy other labels. The bundles were then sun-dried in stooks in the field, and finally stacked. A bundle was opened by two women, who examined each ear in turn, rejecting any that appeared foreign to the bulk. The grain was trodden out under foot by the same women, and thoroughly hand-winnowed, the grain rejected in the initial sorting being added to that shed whilst handling. The following records were taken of B-12. (For brevity, the records for 16 bundles harvested of each strain are summed):—

Date of flowering Jan. 20-24, 1922.
Date of harvest of 1st bundle March 15.
Grain characters (already noted, not repeated here).

Area transplanted 1,456 sq. ft. (app. 1/30 acre).

Yield of seed paddy after thorough winnowing 3,117 lb. per acre.

Weight per bushel 48 lb. 9 oz.

Yield, calculated from weight to volume, 63 bushels per acre.

Yield of straw 5,878 lb. per acre.

Duration, growth to harvest, 180 days.

Amount winnowed away (light grains, chaff, etc.) 10¼ lb. per bushel of seed paddy.

Amount shed in handling (to which is added amount of grain rejected in first sorting) 11 1/3 lb. per bushel of seed paddy.

The large amount of grain shed was chiefly due to the fact that the crop was allowed to get dead ripe for seed purposes. With the heavy sequence of work, with upwards of 850 bundles to sort and thresh, every ear of which was examined separately, much grain was shed in the stack.

For the seasons 1922-23, 1923-24, the paddy was tested on exactly similar lines, being transplanted into 8 plots. The size of the plots was reduced this year to 4 ft. by 40 ft. Seedlings were again spaced accurately at distances of 6 in. in and between the rows. Sowing was done on 23rd September and transplanting on 19th October, in 1922, and on October 10th, and 30th, respectively, in 1923. Records were taken exactly as in the previous year, and the following may be noted:—

	Maha 1922-23.	Maha 1923-24.
Date of flowering.	29. 1. 23.	28. 1. 24.
,, harvest.	21. 3. 23.	17. 3. 24.
Area transplanted.	1,280 sq. ft app. 1/34 acr	1,280 sq. ft. app. 1/34 acre
Yield of winnowed grain per acre.	3,735 lb.	2,652 lb.
Weight per bushel.	48 lb. 8 oz.	——
Yield calculated to volume per acre.	77 bushels.	54·8 bushels.
Duration of growth.	179 days.	187 days.
Loss in winnowing.	9·8 lb. per bushel.	4·3 lb. per bushel.
Loss in shedding.	6·0 lb. per bushel.	9·0 lb. per bushel

During the latter harvest another observer made the following notes of grain character:—

Grain medium to large in size. Awnless. Colour bright rusty yellow, with slightly darker longitudinal streaks. Seed-coat bright reddish brown. Endosperm flinty with a trace of starch.

The work of threshing during this season was greatly hampered by shortage of skilled labour, and much grain was shed in the stack, and later by rats. The yields of threshed grain were correspondingly lowered.

For the Maha season of 1924-25, seed has been sown in a large nursery, and transplanted, in the customary village manner on a field scale, into fields of approximately 1/15 acre. It is now felt that this strain, among others, is sufficiently tested to be released for extensive cultivation in districts where water can be obtained for a six months' crop.

Section 2. Progress in the fields at Harispattu, Katugastota.

In August, 1922, the Director of Agriculture, sent a letter to certain Agricultural Instructors, stating that limited amounts of selected seed paddy of approximately 6 months' duration would be forwarded to them for trial by reliable cultivators or land-owners. Two bushels of each of 5 varieties were to be sent to 8 Instructors, with instructions for a close comparison with local types. The Department reserved the right to purchase half the crop at ruling market rates. At the same time, the Economic Botanist sent out full working details, and described the methods adopted at the Experiment Stations as a guide. Particulars of previous performance in yield and age were included.

It should be realised that a particular type of paddy that succeeds in one district is not necessarily a good type for another locality. These experiments have shown the great risk that is undertaken in moving paddies from one place to another in Ceylon, and that any change of seed should be tried on a small scale first to minimise financial loss. Several of the strains released at the same time as B-12, and subsequently, have proved complete failures in their new conditions. In fact two of the main hindrances to the spread of selected strains of paddy are the unknown degree of their adaptability to fresh conditions of climate, altitude, rainfall, etc., and the conservatism of the cultivator who resents any change of custom and is suspicious of another's success. The experiments had for their primary object the trial, in various localities and under ordinary systems of cultivation, of strains that were known to be successful on the fields of the Anuradhapura Experiment Station.

One bushel of B-12 was sent to Agricultural Instructor W. Molegode, at Katugastota, who has since watched the progress, and to whom credit is largely due for the ultimate success of this strain. This account is based on his reports.

The fields chosen in the Katugastota district belonged to Hapukota Appuhamy and were cultivated by Hapukota Punchirala. The Agricultural Instructor lives close to the fields, and has been able to inspect them frequently and superintend all cultural operations. They are terraced and ella-fed, and comprise a small part of a large valley range, lying off the Kandy-Kurunegala road about 1½ miles from the Katugastota railway station.

After the fields had been ploughed three times, they were levelled and prepared for sowing. The paddy was soaked over night, and heaped for six days, when germination was found to be strong. (This period of six days was excessive. Four days had been sufficient at Anuradhapura, but the local custom is to allow roughly one day in the heap for every month the paddy is expected to be on the ground—a rule of thumb custom that may be compared with that of leaving seedlings in the nurseries, before transplanting, for as many weeks as the crop takes months to mature. These are rough checks, but are frequently inaccurate. It would be far better to *examine* the heap each day, and *observe* when germination is strong enough for sowing; and to *examine* the seedlings in the nurseries, and *observe* when they are ready for transplanting. *i. e.* just before tillering commences, when the seedlings begin to flatten out at ground level in preparation for tillering). The seed was broadcasted on August 18th, 1922, and weeding, and thinning out of surplus seedlings, was done in early October. Four fields were transplanted with the seedlings taken out. Growth was generally good, and the plants were healthy and strong, but a lack of water was felt in the early stages. The Assistant to the Economic Botanist reported on 30th October on "the uniform growth and cleanliness of the fields. The crop is considered a fairly good average.....Comparing the growth with what one is accustomed to observe at Anuradhapura, it may be said that the culms are somewhat thinner and the plants not so sturdy. Generally there are about 2-3 good tillers." It was subsequently noted, as one promising feature of the strain, that ripening was very uniform, both as regards the plant unit and throughout the field.

In mid December, when the plants were flowering, rats did slight damage, but steps were taken to control them. Paddy fly appeared towards the end of December, but was not serious. The Agricultural Instructor reported that the plants had "grown excellently and were carrying long ear-heads." In January he said "the growth of B-12 especially is very striking" Harvesting commenced in mid February, and from the broadcasted crop of about half an acre extent 1,012½ lb. of winnowed grain were taken, equivalent to 2,000 lb. (44½ bushels) per acre. There were 2 bushels of empty husk as a result of damage by paddy fly, unusual rain, etc. The grain was difficult to thresh by buffaloes, as it did not separate easily from the straw. Some of the empty husk was probably due to excessive trampling. The area transplanted was also roughly half an acre in extent, and the crop realised was 10% better than from the broadcast fields. As transplanting was not usual in this range, these fields were used for demonstration and seed supply only, and accurate measurements were not taken. The yield of local *hatial* for the same season was between 30 and 35 bushels per acre.

In the following season, Maha 1923-24, the cultivators' prejudice against this type had so far weakened that 8 pelas (4 acres) were sown in the same range. The high bushel-weight and uniformity had made their appeal. Three acres were transplanted, and one broadcasted. The seed was sown between August 20th and 25th, 1923, and transplanting began six weeks later.

The season was unfortunate. Very heavy rain was experienced and the fields became heavily silted up as the result of flooding and washaways. Most of the plants were completely lost, and less than an acre remained. This, however, "tillered freely and attracted considerable attention." It was impossible to obtain figures for this harvest, as the fields had been so badly cut up by the floods, that plants were growing alone and in groups of two or three in the damaged area. From the eight plots harvested in the first week of March, 1924, 60 bushels of paddy were threshed.

The yield from neighbouring fields of local *hatial*, unaffected by wash-aways, was from 35 to 40 bushels per acre broadcasted. The experimental fields, being near the watercourse and at the foot of the range, bore the brunt of the more serious floods.

For the present Maha season, 1924-25, the demand for seed has increased, and it has been sown in the entire range of 16 pelas (about 8 acres) extent, to the exclusion of all other types. It has also spread to the neighbouring villages of Ranawana where 15 lahas (about ¾ acre) was broadcasted; and Dunuwila where 2 pelas (1 acre) has been sown broadcast. Seed was broadcasted at Katugastota in mid August and the seedlings were thinned out, and the fields weeded, on October 2-10. For the transplanted area, seed was sown in the nursery on August 21-22, and transplanted on October 5-13, over an area of 3 acres, the remaining 5 acres being broadcasted.

The Agricultural Instructor reports, "I believe the paddy has now become properly established, and will, before long, become the chief variety in these districts."

CONCLUSION.

The methods described above for the first year's treatment in the laboratory and on the experiment station were devised by Mr. F. Summers, M. Sc. The writer took over the work in May, 1921, and paddy samples received after that date have been dealt with in a somewhat modified manner. The main differences are set down below.

The informant is encouraged to send in a number of ears, rather than a bulk of unsorted seed. He is asked to select only the best plants, and to make the samples representative of the various types to be found in the field. It has often been possible for the writer to carry out this initial selection himself. In case it is not possible, or advisable, to send ears, a quantity of unsorted seed is asked for, and this is sown on the experiment station fields for selection of ear-types.

Once the ear-types are available, a botanical description is made, including characters of growth, duration, pest, etc., and the seed is then sown either in ear-to-row strips, or in 100 seed square blocks, germinated seed being dropped through holes arranged in a square board three inches apart in either direction. A few grains are retained for record purposes.

The ear-to-row strips are wasteful of space, as it is necessary to leave 3 feet uncultivated on either side to minimise cross pollination. The block tests have the added advantage that the plants in the centre are removed from any danger of contamination from foreign pollen.

Whichever shape of plot is chosen, it is easily possible to note the characters of individual plants throughout the growing period, and to weigh up the plants at harvest time, using the weight of grain per 100 plants as a basis of comparison between the various pure lines of the same variety. Any plots showing the slightest departure from uniformity of type are discarded.

Seed from the best of these plots is sown in nurseries and transplanted, in several repetitions, into standard beds of 4 feet by 40 feet, seedlings being spaced accurately 6 in. apart in either direction. Here the basis of comparison is the plot yield, but each ear is again hand-sorted for uniformity of type.

The final stage is that of field trial, in which the paddy is tried under normal (as opposed to experimental) conditions, and seed becomes available in quantity for supply to the cultivator. It is never advisable to release seed to the cultivator before it has passed the field test on the experiment station.

There being no Government-owned paddy fields available, strain B-12 was released early for trial on private lands, but it is obvious that the

success of such a procedure depends upon the attitude of the landowner or cultivator, and that he takes the risk of financial loss if the crop fails.

The yield of B-12, year by year, at the Experiment Station, Anuradhapura, has never been at the head of the list. There are several strains which have consistently given higher yield figures, amongst which the following may be noted:—

No. of Strain	Varietal Extraction	Age in days				Yield of winnowed grain in Quarts per 100 plants				Average yield of cleaned paddy for last 3 years in lb. per acre
						lb per acre				
		1920-21	1921-22	1922-23	1923 24	1920-21	1921-22	1922-23	1923-24	
B-27	Kohu Mawi C.P.	?	184	194	189	4·78	3,809	4,917	3,360	4,021
W-15	Mawi N.W.P.	169	168	178	176	4·96	4,000	4,486	3,576	4,015
B-20	Kohu Mawi C.P.	?	184	193	189	4·56	3,645	4,570	3,470	3,895
F-25	Sudu Mawi W.P.	155	166	172	168	5·24	4,138	3,599	3,674	3,803
I-17	Sudu Mawi C.P.	?	184	180	189	4·55	4,512	3,786	3,093	3,797
B-13	Kohu Mawi C.P.	?	184	192	189	7·04	3,772	4,336	3,165	3,757
W-11	Mawi N.W.P.	169	166	169	176	4·95	4,470	3,448	3,204	3,707
E-24	Kalukan Mawi W.P.	163	166	172	170	3·86	3,924	4,427	2,669	3,673
I-39	Sudu Mawi C.P.	?	184	194	189	4·83	3,215	4,339	3,387	3,647
B-11	Kohu Mawi C.P.	180	179	178	187	4·72	3,566	4,152	3,137	3,618
a-12	Podi wi W.P.	177	168	178	181	3·91	3,626	3,930	3,008	3,521
a- 8	Podi wi N.W.P.	177	168	178	179	3·88	3,361	4,208	2,918	3,495
B-14	Kohu Mawi C.P.	?	185	192	189	5·36	3,735	3,914	2,782	3,477
P-10	Sudu Mawi N.W.P.	180	168	171	184	5·26	3,615	3,963	2,756	3,444
G-19	Maha Mawi W.P.	156	153	155	160	3·66	3,484	3,224	3,535	3,414
g-18	Molagusamba W.P.	177	166	183	179	3·15	3,582	3,574	3,117	3,404
E-14	Kalukan Mawi W.P.	168	166	174	167	4·20	3,496	3,845	2,614	3,318
P- 5	Sudu Mawi N.W.P.	162	168	170	184	4·34	4,119	3,449	2,361	3,309
P- 1	Sudu Mawi N.W.P.	168	166	159	184	5·21	4,175	3,638	2,091	3,301
I-36	Sudu Mawi C.P.	?	184	180	189	4·73	4,228	3,017	2,550	3,265
F-7	Sudu Mawi W.P.	144	166	172	170	5·26	3,309	4,050	2,235	3,198
K-5	Goda Mawi S.P.	156	153	155	157	4·48	3,167	3,522	2,896	3,195
B-12	Kohu Mawi C.P.	176	179	180	187	3·89	3,117	3,735	2,652	3,168

Most of the above strains will be available in April, 1925, in quantities ranging from 4 to 15 or 20 bushels. The paddy may be issued free of cost to approved cultivators who will undertake to sell to the Department of Agriculture half the resulting crop at ruling market rates. The Department reserves the right to select from the crop such part as it deems fit, if there appears to be any deterioration of type through mixing of seed, or other circumstance.

RUBBER.

BROWN BAST.

Mr. P. E. Keuchenius, of the Rubber Research Department of the United States Rubber Plantations, Inc., has very kindly sent to us a paper on his investigations of the Brown Bast disease of rubber.

Mr. Keuchenius is a very able scientist and his conclusions regarding the cause of Brown Bast and his method of treatment should deeply interest planters. Below we give his method of treating Brown Bast.

Although with my previous method a considerable improvement and advantage was obtained, the loss in yield by the disease was still of great importance. This loss is of two kinds, direct and indirect. The former is caused by the drying out of the area of bark, which is affected by the disease. The larger this area, the higher the direct loss in yield. With my method of treatment the number of large cases Brown Bast is decreased to such an extent by the early detection of the disease, that the direct loss in yield is of little importance and is much less than the indirect loss. The latter is caused in all cases when a smaller or a larger affection occurs in the middle of the tapping cut. It is then only possible to tap at one side of the diseased areas for some time, so that the yield of the opposite side is lost. This loss of yield at one side might be obviated by tapping with two shortened cuts on either side of the infection, but for this two spouts and two cups are required. This was done on H.A.P.M, but only with high yielders. In practice it is too difficult to tap all trees with affections in the middle of the tapping panel in such a manner because too much tapping material is required which, when the tapping cut has reached below the diseased area, will become superfluous and may be lost.

TO AVOID INDIRECT LOSS OF YIELD.

A change in the treatment previously applied will avoid indirect loss of yield and the difficulties of tapping with shortened cuts. In principle, however, the treatment has remained the same as before.

The inspection of the tapping cut to find out the smallest affected area is still done by scraping clean the freshly-tapped cut with a small stick twice a month.

With affections of which the discolouration on the tapping cut is longer than one inch, the boundaries of the disease are traced in the same way as before by scraping, but not deeper than is necessary to see these boundaries clearly. Thus, with deep seated affections near the cambium, the bark of the disease boundaries will be thinner than with more superficial affections.

AN INCISION TO THE WOOD.

As soon as the scraping of the boundaries is done, an incision is made to the wood with a sharp pointed knife, ¼ inch outside the discolouration but surrounding and isolating the diseased area. The treatment is now finished. Tapping may be continued over the whole length of the cut, provided that the bark at the disease boundaries is thick enough to keep the latex on the cut. If this is not the case, the cut must be shortened to this point and should be lengthened as soon as possible. It is unnecessary to scrape the isolated area superficially to obtain a rapid drying up as was formerly recommended, because this drying up will not be a disadvantage for the tapper would then be tapping over dry and hard bark.

HOW TO TREAT SMALL INFECTIONS.

Small infections, of which the discolouration on the tapping cut is just an inch long or less, are treated as follows :—

For such cases a piece of tin or zinc is given to the cooly in the form of an isosceles triangle of which the base is 6½ CM. long and the sides 10½ CM.

This triangle is placed on the tree with its base on the tapping cut and the top perpendicularly underneath the discolouration. Near the point a small but deep groove is made with a tapping knife to inspect whether the discolouration continues further downward. If this is not the case, then along the sides of the triangle incisions are being made up the wood with the above-mentioned sharp knife.

The treatment is then finished.

The isolation thus has the shape of a V which is left open on the upper side above the length of the cut and tapping may be continued unhindered over the whole length of the cut. It is very necessary that, for this manipulation, the knife be very sharp at the point and that it is not moved sidewise while making the incisions.

THE QUARTER INCH OUTSIDE.

If it is obvious from the groove made that the discolouration extends further downward, the treatment must be carried out as is described for the large affections. Large cases always offer a greater change for metastasis. Very minute cases, of course, need not be isolated according to the maximal size of the triangle if the precaution is made of always making the incision ¼ inch outside the discolouration.

It is emphasised again that, if the V is closed, the soft bark above the tapping cut will sometimes dry out but this does not occur if the V is left open.

With this new method of treatment the infected area is gradually tapped away after the danger of metastasis has been averted by a minute isolation cut to the wood. The indirect loss in yield, which was mentioned before, is practically obviated. Even the direct loss in yield is decreased because this is now only caused by the loss of latex out of the affected latex vessels.

BURRS DO NOT FORM.

The unaffected latex-rings of the isolated area remain producing and the quantity of latex given is, with many trees, not unimportant, especially after a few months when, by the cambial activity, new latex rings are added to the bark. In passing be it remarked that the formation of burrs is averted.

The loss in yield by Brown Bast is reduced with this new method of treatment to very small proportions. The gain in yield can be readily calculated by the data which are at my disposal and I may say without giving such figures that the gain in yield obtained through the adoption of this method is very considerable.

AN IMPORTANT POINT.

This is the most effective manner which one can imagine to exhaust the trees according to the defenders of the physiological theory. I can, however, state that this method of treatment has been applied over the whole H.A.P.M. area of 40,000 acres without increasing the incidence of Brown Bast and thus supplies me with another argument against the physiological theory of the disease.—The Malayan Tin and Rubber Journal, Vol. XIV. No. 2.

TRANSPORTATION OF LATEX.

PHILIP SCHIDROWITZ.

In view of Dr. Van Rossem's recent paper on latex (delivered before the Institution of the Rubber Industry last month) and the discussion thereon, some particulars furnished by the United States Rubber Co., Ltd., as to the methods adopted by this corporation for transporting latex from the plantation to the factory, are of particular interest.

At the present time it is stated that the U. S. R. Co. ships about 250,000 gallons monthly from Belawan, Sumatra and Port Swettenham, F.M.S. These ports are provided with storage tanks and tank lighters. Four steamship lines are equipped to carry latex cargoes in tanks.

On the estates the latex is poured direct from the coolie's pans into a small weighing tank, from which, after careful weighing, it is discharged into a collection tank. The latter consists of a circular thin steel shell of about 600 gallons capacity, with dished bottom and closed top, the latter provided with a door and latex stainer. Such tanks are mounted in an open shed and elevated to facilitate the subsequent discharge of the contents into motor-truck tanks. The strainers are of aluminium, and are provided with a steel deflecting plate, which throws the latex towards the side of the tank, with a view to reducing "foaming." At the bottom of the tank there is a 4 in. outlet fitted with a gate valve, and with a coupling and filling hose of sufficient length for discharging. After bulking and an addition of ammonia as a preservative, the latex is ready for the first step on its journey.

From the collection tanks the latex is discharged into horizontal tanks of about 250 gallons capacity (fitted with standard gate valves couplings) housed on motor trucks. In the latter the latex is run to large station storage tanks at convenient rail points. Here it is again accurately weighed.

The "Station" storage tanks are horizontally-disposed vessels, 60 feet long by 8 feet diameter, and hold about 18,000 gallons. They are designed to stand a pressure of 50 lb., have no internal supports or bracings, and are installed in concrete pits below rail level, the pits being covered by a low roof and located parallel with a railway siding. The equipment further comprises a weighing shed and a compression plant. The gross weight of each motor-truck tank is taken on arrival, and its net weight after discharge and cleaning.

From the station storage tanks the latex is forced by means of compressed air into railway-car tanks holding about 10 tons of liquid. The outlet valve of the railway-car tank, operated by a key, is situated at the bottom of the same, and is connected with an outlet pipe extending to both sides of the under frame, and fitted with standard two-bolt couplings. By filling through the bottom of the tank foaming is entirely, it is said, eliminated.

At the tidal wharves the latex is discharged by gravity from the railway tanks into storage lighters. The latter contain two 40 feet by 10 feet tanks, of a capacity, jointly, of some 175 tons. From these lighter tanks the latex is forced by means of compressed air (generated by means of a 20 h. p. motor and an air compresser located on a special lighter) into steamer tanks

in the same way that it is forced from the station storage tanks into the railway tanks. By means of a 2 inch hose the latex is run into ships at a rate of 150 tons per hour.

On arrival at New York the latex is transfered by pumping into railway-car tanks taken alongside the ship by means of a barge, such tanks having a capacity of 8,150 gallons (*i.e.*, about 43 tons).

It is obvious that a not inconsiderable proportion of the cost of a transportation scheme such as the above must be allocated to the return of the various tanks in an empty condition and to thier spherical shape. Is it too much to expect that some genius will invent a small *collapsible*, square or rectangular tank, capable of journeying direct from estate to factory, and of being returned collapsed and packed flat? It is true that oil is conveyed in "tankers," and that no better method has been devised, but oil presents very special difficulties. The problem, no doubt is a pretty complicated one, for even if the collapsible small tank were evolved, the prime cost plus handling might still be greater than that of the series of storage and movable tanks described, notwithstanding the "return" freight charges. Yet there is here much food for speculation, and I should not care to discourage inventors from considering this problem very carefully.—India-Rubber Journal, Vol. LXVIII. No. 26.

ON A CASE OF DEGENERATION OF LATEX VESSELS IN HEVEA.

DR. W. BOBILIOFF.

(Summary of a Paper.)

A peculiar case of degeneration of latex vessels in the leaves at leaf fall has been described. It appears by walls growing and inward thickenings of latex vessels by which sometimes a division of the vessels in rooms apart begins. The shape of the vessels, irregularly swollen outward grows abnormal.

Here is a case of "celluloid degeneration." As a result of the contraction of the contents in the centre of the vessels, the whole space between the contracted contents and the original membrane may be filled with a membraneous material.

The contracted contents of latex vessels can form a membrane around. This may be considered as a proof for the living nature of the latex vessels. So in this respect there is an analogy between latex vessels and ordinary plant cells.

The appearance of the so-called crystals of Rosanoff in Hevea has been demonstrated. They consist of calcium-oxalate surrounded by a membrane which sometimes is connected with the cell membrane by growings.—Archief Voor De Rubbercultuur, 8e, No. 12.

FIBRES

COTTON BUYING IN NYASALAND.

J. ARTHUR LEE.

Cotton grown by natives on Crown land is bought in Nyasaland under agreement between the Nyasaland Government and the British Cotton Growing Association, the grower being assured at the commencement of the planting season of the minimum price he will obtain when the cotton is harvested. The planting season varies according to the altitude but December may be taken as the time for planting in the higher elevations, and January to April in the Lower Shire River districts; the cotton is usually offered for sale towards the end of June, and buying takes place from that month until November.

With an agreement such as the one in force in Nyasaland, the native is assured of a fair return for his labours; he is not in the hands of speculators, who, in the past, have bought his cotton at high prices in boom periods, and have left him with it on his hands when markets were low; this more than anything else was responsible for the falling-off of native cotton growing in Nyasaland. The local native does not understand market fluctuations, and is perfectly satisfied if he obtains a fair and remunerative price for his product. The object of the originators of the scheme was to fix a price to be standard throughout the period of the agreement (five years), any surplus funds after realization on the cotton market being placed in a reserve fund to be used to stabilize prices in the event of a fall in the price on the cotton market.

A season's working of the scheme has resulted in increased activity in native cotton growing in this Protectorate, the natives being more than satisfied with the amount of money obtained, and the writer, in the course of visits to different buying stations, saw their looks of amazement and pleasure at the money they held in their hands; some of them came forward expressing their intention of growing more next season. From 250 native planters in one district in 1923, the number has increased to over 1,500 in 1924.

Markets, or buying centres, are established in the principal villages, but in the large cotton-growing areas, buying stations are fixed at points about 15 miles apart; therefore, the native has not at present to carry his cotton more than $7\frac{1}{2}$ miles. As the industry expands, it is proposed to fix the buying stations at 10-mile points.

In order to suit the different temperaments, the system of markets varies somewhat. Some like to bring small quantities in daily as picked, and the market is open from sunrise until a little before midday; in other districts a date is fixed when the bulk of the cotton is ready, and the crop is bought in and finished within a month. At the latter markets from the first streak of dawn numbers of natives—men, women, and children—may be seen wending their way to the market each laden with various-sized packages on their

heads, the average weight of which is about 45 lb., the most popular form of package being made of dried bamboo, the bamboos being laced together with tough broad grass and the ends covered with what looks like chicken netting of the same material. Others bring it in large open and well-made wicker baskets, the cotton being heaped well up over the top and covered with netting also made of grass or strips of palm-leaf; the circular bamboo package is preferable, as the cotton is more completely protected.

The native having arrived at a market, proceeds to sit as near the weighing-scale as possible, and considerable time is often taken, at some of the markets, in getting the mass of natives who have assembled into something like order. At others, in localities where a number of the natives have had military training, something like order prevails, and the buyer on arrival finds the sellers more or less arranged in an orderly queue. It may be explained at this point that, although Nyasaland is a comparatively small country, we have probably a greater diversity of tribes than other countries, and, as cotton is grown from the northern to the southern end of the Protectorate, the customs, manners, and mode of attire are very striking. The natives of the southern end are practically nude, but as one progresses north thay are better clothed and more intelligent, the most picturesque being the stately Mahomedan Yaos on the shores of Lake Nyasa.

A buyer, too, gets his Biblical knowledge refreshed when he encounters the natives in the West Shire district, as owing to mission influence they have adopted Biblical names, and the names of the disciples are in greatest favour. This is not the case in the Lower Shire River district, as one comes across male natives with names of Empress, Princess, and Countess—taken from the names of some of the river steamers.

As to the actual buying of the cotton. The sellers having assembled, the buyer proceeds to weigh in, the cotton having been emptied into open baskets 4 x 2 x 2 feet fitted with two wire slings, the tare of which (10 lb.) is legibly stencilled on the outside. The baskets are brought forward to the spring balance by the owner, who gives his name to the native clerk. The buyer, a white man, shouts out the classification, weight, and price per lb., and this is recorded and entered on a numbered duplicate purchasing form, the owner's name, village, and chief's name having already been recorded. The original is then detached and handed to the owner, who retires to the nearest shade and waits until some fifty baskets have been weighed in. The buyer then pays out, while the baskets are being filled again; the seller hands in his receipt and is paid, the receipt also being handed back to him; this is done so that he can, if he wishes, take his money and voucher to the magistrate and get it checked. It will be asked, but how can an uneducated native tell how much he ought to get? The native has a very good idea of what weight he has in his package, and what he received for it in a previous season; if he has grown more or has had a better yield, he makes it up into packages exactly the same size, has them weighed separately, and receives a ticket for each. A variation naturally occurs, but it is only a pound or two, and the owner understands this from the few extra pence he has received over and above the silver money. At one market the writer visited he was surprised to see several natives with ready reckoners, and as the weight and price was called out they jotted it down, and checked the amount on the voucher.

Taken on the whole, the native does not try any fraudulent practices, but the cotton being emptied into open crates makes their detection a simple matter. Occasionally they slip stones into the bulk or hide inferior grades at the bottom ; the buyer detects this by running his hand through the contents, and when he withdraws a large stone he presents it to the owner, to the accompaniment of the jeers of the surrounding natives, who do not hide their delight at the culprit having been found out.

The cotton offered is classified into three grades, No. 1 being clean white cotton free from leaf, No. 2 stained and white mixed or white with leaf, No. 3 stained cotton. Better prices are paid for the higher grades, and the natives understand that by grading they receive a better price ; the percentage of No. 1 last season was 60 per cent.

The selling of his crop is to the native what a country fair is to the farmers at home, and gives the village something to talk about for some time to come ; it also means, after he has paid his hut tax, a visit to the Indian store, where a new cloth is bought for the wife and a shirt for the husband. The purchasing of these often takes a considerable time, as the female natives are quite keen on shopping, and fashions are also in vogue in Nyasaland, certain colours or the pattern changing each season. Once cotton-growing is firmly established, and the native realizes the value of money, more cotton will be grown : the unclothed, after wearing a shirt or a pair of shorts until they are worn out, feel the heat of the sun (the temperature in the cotton-growing areas often reaching 112° to 115° in the shade,) which they did not before. Clothing, therefore, will have to be bought, and to get the money to purchase this, cotton will be grown, since this crop is easily the most profitable to them.

In conclusion, a word may be said as to the buyer in charge at the different markets. Where possible, the post is given to a planter or ginner in the vicinity of the market, as he is well known to the natives round him, and will in his own interests do his best to please them. Also being resident there he is more or less certain to give them every encouragement and advice to grow more the following season. Payment to these buyers is made in the form of a commission on the tonnage bought ; therefore, being more or less assured of the position, it is also in the buyer's interests to have more produced. His duties in addition to the buying are to see to the bagging and forwarding of the seed cotton to the nearest ginnery. Opportunity is also taken at these markets to encourage better cultivation, and the uprooting and burning of the old bushes after the crop has been harvested ; at the conclusion of buying last season, these buyers were appointed inspectors, and they, knowing their district thoroughly, went round and saw that the regulations of the Cotton Pest Act were carried out. These men, who all speak the local dialect, explained in the vernacular the advantages derived by the uprooting and burning of the bushes, and evidence of their work is to be seen this year in the reduction of pests. In short, the cotton buying scheme in Nyasaland interests everyone : the Government are interested, the native gets a guaranteed price with which he is well satisfied, the local planter a share, and also Lancashire gets the cotton it needs.—The Empire Cotton Growing Review, Vol. II, No. 1

A METHOD OF PROPAGATING VARIETIES OF COTTON FROM VERY SMALL AMOUNTS OF SEED.

KALIDAS SAWHNEY, M. Sc.,

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INTRODUCTION.

In raising plants from the seed of a single selected boll of cotton, or from the seed of a boll which is the result of a deliberate cross or self-pollination, it will be realized that the ordinary method of field sowing which requires the planting of four or five seeds per seed-hole involves an unjustified waste of precious seed, especially in view of the fact that in the final thinning of the crop all but one of the plants in each hill have to be removed. The alternative method of planting only one or two seeds to the hill gives invariably a poor stand. An improvement can be effected in the germination by covering the sown seed with sand instead of with ordinary soil. But even the use of sand does not always ensure a good stand of the resulting crop. This is especially the case when a spell of cold weather immediately succeeds the sowing of the crop. This difficulty of getting a good germination is more marked in heavier soils than in light soils. Unfortunately, the soil of majority of the breeding plots of cotton at the Agricultural Experimental Station, Baghdad, happens to be of a heavy nature. It is a heavy silt soil, rich in lime and difficult to work. In the course of breeding cottons during the past three years in the locality the writer has often had to be contented with only a few plants, when his requirements both for genetic study and the propagation of new strains demanded the raising of as large a number of plants as possible from the strictly limited quantity of seed at his disposal.

During the sowing season of 1923 an experiment was carried out to determine the possibility of transplanting cotton seedlings with a view to raise the largest possible number of plants in the breeding or propagation of a new type from a limited quantity of seed.

It is generally considered that cotton plants cannot be transplanted successfully under commercial conditions. But for purely "experimental" purposes, and under very special conditions of culture, the successful transplantation of cotton seedlings is not a difficult matter.

METHOD OF THE EXPERIMENT.

The method adopted in the experiment may be summarized as follows: A layer of sand about 2 inches in thickness, and resting on a piece of tin measuring 12 by 8 inches imbedded at surface level in a plot of land, was used as a seed bed. In this particular experiment there were four such beds lying side by side on the ground. A shallow groove was prepared in the soil round each bed. In order to keep the sown seed sufficiently moist for germination, water was let in this groove when required.

On April 24, 350 seeds of the variety of cotton called *Webber* 49-3 were sown at 1-inch intervals in these four beds of pure sand. Before sowing the seeds had been kept overnight in water.

After the completion of germination these layers of sand along with the basel plates of tin were removed *en bloc* into sieves made of close-meshed wire gauze, the margins of which had been sent upwards. These sieves were then held over a slowly running stream of water in such a way that the water of the stream could effectively wash away the sand, but could not carry any germinated seedlings with it. After all the seedlings had been washed, they were carefully transferred to a basin of water, which

was covered with a piece of black cloth to prevent the sunlight from falling directly on the roots of the young plants.

Two days previous to the washing of the germinated seedlings a small plot of land had been ridged; and, in conformity with our field practice for commercial cotton cultivation, the land was given a presowing irrigation to determine the water line on the ridges in the plot. The washed seedlings were now planted on these ridges in holes of requisite depth made along the previously determined water line. The planting was done by inserting in an upright position the whole of the radicle and half the length of the hypocotyl of each seedling into the seed-hole, which was subsequently filled with sand, care being taken to leave uncovered the cotyledons and that part of the hypocotyl immediately below them. The rate of planting was originally two seedlings to the hill, but as the root tips of some of the young plants were broken through careless handling, the rate of planting was increased to three seedlings per hill. In this way a total of 113 hills was transplanted.

A light watering was given immediately after sowing, and another watering a week later. No other irrigation was given until the plants actually required it a month later.

RESULTS OBTAINED.

The data collected in the experiment are given in the subjoined table.

1	2	3	4	5	6	7	8
Date of sowing	Number of seeds Sown in Sand	Number of seeds Germinated	Percentage of Germination	Number Days taken to complete Germination	Date of Transplanting the Seedlings	Number of Seedlings Transplanted	Rate of Planting
April 24, 1923	350	340	97·1	Six	May 1, 1923	339	Three Seedlings per hill

9	10	11	12	13	14	15	16
Total Number of Hills Sown	Number of Hills with Successful seedlings			Successful Hills as a Percentage of Hills Sown	Total Number of Plants Survived	Survived Plants as a Percentage of the Total Number of Seedlings sown	Remarks
	Two Seedlings per Hill	Three Seedlings per Hill	Total				
113	67	44	111	98·2	266	78·4	Figures given in columns 10 and 11 are those recorded on June 5, 1923

This table is largely self-explanatory. We may, however, refer to the fact that the number of seedlings surviving on June 6 when expressed as a percentage of the total number of seedlings originally sown (see column 15 in the table) is not very high. The low percentage of seedlings that survived may be explained by the fact that the root tips of some of the seedlings had been injured during the operation of planting them on the ridges. Given the careful handling which is necessary at the time of washing the seedlings, and also subsequently at the time of planting them on the ridges, it should be possible to obtain results much better than those obtained in the experiment described above.

SUMMARY.

The comparatively small number of seeds produced per boll of cotton is a decided disadvantage so far as breeding from single bolls is concerned.

The ordinary method of sowing cotton is not suitable for growing plants from the seed of a single selected, selfed, or cross-pollinated boll, because it is wasteful. The cotton breeder cannot afford to sow four or five seeds to the hill and then remove a majority of the plants in the event of a good germination being secured.

When only very small amounts of seed are available, a satisfactory stand of cotton seedlings can be obtained by raising a crop in pure sand, washing the germinated seedlings in running water, and finally planting them on ridges in the way described in the foregoing pages.

To obtain really good results great care should be exercised both when washing the seedlings and subsequently when transplanting them into their permanent position. Injury to root tips should be avoided at all costs.—The Empire Cotton Growing Review, Vol. II. No. 1.

SISAL-HEMP IN THE GOLD COAST.

The backbone of the prosperity of the Gold Coast is the cacao industry, to the cultivation of which the forest areas are mainly given over. Cacao forms the chief article of export, and it amounts to nearly half the world's supply of that product.

There is, however, a belt varying in width up to 20 miles of dry more or less barren land between the coast and the forest regions in the eastern part of the Colony, where the cultivation of cacao is impossible. This area is at present neglected except for the sparse cultivation of some food crops such as cassava for local consumption. With the object of utilising these waste lands and becoming less dependent on one particular industry, the Government, in 1920, commenced a Sisal Plantation to demonstrate the commercial possibilities of the product.

The rainfall is in the neighbourhood of 25 inches per annum, with a regular wet season—May-July, and a secondary wet season around October. Rain falls chiefly in tropical showers, and no difficulty is experienced in drying fibre even in the wet season.

An area of 1,000 acres was borrowed from the Chiefs of Accra, compensation at the rate of a little over £1 per acre being paid to the dispossessed farmers. As it happened, the year 1920 was a "boom" year in the Gold Coast, and the highest prices were ruling for both materials and labour. Sisal-hemp plants being scarce, high transport charges had to be incurred to obtain them from distant stations, some being procured from the neighbouring country of Togoland, where a plantation had been commenced during German occupation.

The planting of the 1,000 acres was completed in 1922, and, with the exception of the year 1921, which was excessively wet, the plantation has been kept cleanly weeded. Both bulbils (the small plants borne on the poles) and suckers (the plants which spring up from underground runners) were used in the planting, the local supplies being found to be superior to those from Togoland. The plants have grown well and have been free from disease.

The earliest planted areas were ready for cutting at the commencement of the present year, but owing to delays in the delivery of the machinery, a start was not made until July. A factory equipped with the most modern decorticating, brushing and baling machines, made by Robey of Lincoln, has been installed and a light railway laid down for the conveyance of leaf to the factory. As water is not very abundant, the refuse is at present removed in tip trucks and dumped. Owing to the lack of fuel in the district, a 100 h.p. Semi-Diesel engine, using crude oil, also made by Messrs. Robeys, was imported. The capital cost, including all European supervision, and the installation of the above machinery, is about £35 per acre. This figure includes, of course, the erection of all buildings necessary for the accommodation of Europeans and native staff.

The yield from the leaf has been found to be 3·5 per cent. of dry brushed fibre. Samples have been submitted to the Imperial Institute for examination, and have been reported as being of excellent quality. The planting distance is 7 ft. by 7 ft., giving nearly 900 plants to the acre, and the average yield from the first cuttings has been 15 cwt. to the acre—a yield of one ton per acre being obtained from the best area yet cut. The cost per ton of fibre from the one month's working was £18, including factory and plantation costs and supervision, and the high rate of 7s. per 1,000 gallons of water. It is expected that these figures will decrease in time; boy labourers for the lighter work are scarce at present, while the supply of local labour fluctuates.

One great advantage in connection with the situation of the land surrounding the plantation is that it is so close to shipping facilities. The proximity of the Colony to European markets also compares very favourably with that of other fibre-producing countries; thus reducing the high transport charges so prevalent elsewhere. A further £4 per ton to the production cost should suffice to place the fibre on the market, and as the price

of sisal appears rising owing to shortage in the European markets, an excellent profit should be obtained. *Tropical Life*, of course, gives the current value of sisal compared with other fibres every month and has done so for years past.

Shipments of some 40 tons have already been made to England, and the factory is now in regular operation.

The primary object of the Government is to interest the local natives in the production of sisal, and it is hoped that the industry may be developed on a co-operative basis by native growers with a central factory. No extension of the Government plantation is proposed but local farmers would be encouraged by the provision of transport facilities, free plants, and advice to plant small areas in the immediate vicinity. The crop is one which should appeal to the small farmer, being extremely hardy, capable of standing periods of long drought and requiring no great attention or upkeep after the initial stages. Small catch-crops, such as groundnuts, might also be grown during the first year, but no heavy or exhausting crop should be either planted or expected. Nor need the cultivation of sisal on a small scale interfere with food production for the farmer.

It is hardly probable that the factory could ever be run entirely under native supervision; but with European supervision and the existing plantation as a working nucleus, a series of small farms should prove excellent investments for local farmers. Given the interest of the local farmers there appears no reason why a profitable industry in sisal should not be developed in the coastal regions of the Gold Coast, thereby utilising the land to the full whilst distributing the risks and increasing the revenue of individual and Government alike.—Tropical Life, Vol. XX. No. 12.

THE DANGER IN RATOONING COTTON.

G. B. SYMES.

In Egypt and some other countries where the boll-worm is rife, it has been found necessary to introduce legislation prohibiting ratooning, and enforcing the destruction of old crops by a given date. Such measures were absolutely essential. After many years of slovenly methods, coupled with indifference to the advice offered by scientists, the very existence of the cotton-growing industry was threatened, and nothing but drastic action by the Government would save it. It is obvious, of course, that where ratooning is practised the most important preventive measures against insect pests cannot be as thoroughly carried out as is possible where cotton is an annual crop. Growers who are obliged to ratoon, therefore, must concentrate on those operations that can be carried out; they should cut down their plants as early as is consistent with the welfare of the crop and see to it that no cuttings, leaves, or plant refuse of any kind are left on the land. Commonsense is much better than legislation.—The Agricultural Gazette of N.S.W., Vol. XXXV., Part 9.

FRUITS

SMYRNA FIG CULTURE IN WESTERN AUSTRALIA.

CHAS. SIMMONS,

Orchard Inspector.

The commercial dried fig is the product of the fig tree known as the Smyrna fig. This variety of fig tree differs from the Mediterranean or Adriatic fig with which we are so familiar in this State in that Smyrna varieties are not self-fertilising. They are dependent for fertilisation on the pollen of the Capri, or wild fig, and the existence in the Capri fig of a minute wasp as an agent to carry the pollen from the Capri to the Smyrna fig. There are many named varieties of Smyrna fig trees, but because of its superior appearence, flavour, size and keeping qualities the Lop Smyrna (*Lob. Injir*) has long been recognised as the fruit most suitable for commercial use. The trees of this variety that have been planted in Western Australia are making good headway. They compare favourably with the common Adriatic fig trees in growth, production, and in their adaptability to the soils of the coastal area of the State. The Lop Smyrna is a strong upright grower, and after being once pruned to shape these trees do not require any further pruning. In a commercial orchard the trees should be planted 40 feet apart, and require cultivation and manure in the same manner as other orchard trees.

Capri fig trees are planted at the ratio of one to every ten Smyrna trees to provide enough wasp bearing figs to caprify the figs on the Smyrna trees. On 20th December of each year the main part of the crop of Smyrna figs are about five-eighths of an inch in diameter. They are then awaiting fertilisation. At the same time the spring crop of Capri figs is ripe and the minute wasp, dusted with the pollen of the Capri fig, is emerging from the eye of the Capri fig. The Capri figs are gathered into small baskets made of wire netting, each holding about six figs. Three such baskets are enough to fertilise the crop of a very large Smyrna tree. These baskets are hung in the Smyrna trees, and after four days' interval are refilled with Capri figs: a third refill may be necessary to caprify the most backward of the young Smyrna fig crop. The Smyrna figs are receptive to pollen from the time they are three-eighths of an inch in diameter up to one inch in diameter, but after a certain limit of size and time without caprification the figs become yellow and fall off. The wasps come out of the eye of the Capri figs dusted with Capri pollen, seeking a place wherein to lay their eggs : after entering the Smyrna fig and while crawling over the florets and trying to oviposit, the pollen falls upon the stigma of the fig florets and produces fertility in the Smyrna fig. the wasp, unable to deposit her eggs, becomes exhausted, creeps into the scales at the eye end of the fig and dies.

In March the figs are ripe enough to cure and pack. The fig is only fit for drying when it is dead ripe: therefore, the fruits must be gathered several times as they become ready. In picking the figs care must be taken to retain the stalks. The fruit is placed in perforated buckets, and dipped in and out of a solution of three ounces of salt to a gallon of water. The brine solution must be kept at boiling point, and each pailful of fruit dipped in and out quickly four or five times. The figs are then spread upon trays, eye upward, and the trays are laid in the sun for from six to ten days. After two or three days of drying the syrup in the figs has become jellied, then the fruit is turned over to expose the under side to the sun. If picked when properly ripe it should not take longer than six days to dry the fruit, but as figs dry unevenly those not quite dry enough can be left a day or two longer. The figs are then placed in sweat boxes, having a loose lid fitting inside the box; a heavy weight is put on the lid to press the figs into a compact mass and bring them to a uniform condition. In a week's time the figs are ready to pack, but they should first be dipped in a $2\frac{1}{2}$ per cent. solution of boiling brine. The fruit is then spread upon trays and dried as quickly as possible. All overdried or too poor fruit is removed, and the bulk sorted into two or three qualities. The second dipping makes the skin of the figs smooth, soft and pliable, and packing into cartons or small boxes the figs are worked to a flat shape between the finger and thumb, presenting to the buyer a large round light-brown smooth fig, and is worth from 10*d*. to 1*s*. 2*d*. per lb. wholesale.

The Capri or wild fig tree is indigenous to Asia Minor. In America and Australia varieties of Capri have been cultivated and named. The best known in Australia are Roeding's California, varieties Nos. 1, 2, and 3; Robson's Special, and a local seedling called "Simon's Capri." The last named is an accidental seedling tree found growing in the yard of a house in East Fremantle, now producing enormous crops of large Capri figs, which has, by itself, afforded a home for the fig wasp since its introduction in 1900. Capri trees produce an inedible fig usually dry, but in any case, as its flowers are simply a mass of tiny insects, the figs are not fit to eat. The trees exist apparently for the sole purpose of producing figs superabundant in pollen and fruit to afford a home for the fig wasp (*Blastophaga grossorum*). This insect passes its life from the egg stage to the adult state inside the Capri fig fruits.

The female wasp comes out of the eye of a ripe Capri fig ready to lay eggs, and forcing her way through the eye of a small Capri fig enters the hollow receptacle, deposit an egg in each of the gall flowers lining the inside of the fig, and dies. The Capri fig from that time on nourishes an insect in the ovaries of the flower instead of a seed, and each fruit carries several hundred wasps. The male being the first to issue from the gall flower, immediately begins crawling over the surface of the flowers, gnaws an opening through the membrane of the gall and impregnates the female while she is still within it. The males are minute, brown, wingless insects, seldom found outside the fig. The females push their way out of the opening made by the male and issue from the eye of the ripe Capri figs, complete, winged, ready to find another fig in which to deposit their eggs, and so carry on another generation. The life cycle is accomplished in Western Australia in 12 to 13 weeks in the summer time, but in the winter season is extended to about 27 weeks.

Capri trees produce three crops of fruit during the year, and as each crop ripens the wasp emerges, and it is, therefore, necessary that as each crop ripens there must be small young figs also in the trees ready to take the wasp to carry on the next generation. The local seedling before mentioned has marked advantages over the Roeding's varieties in this particular, for whereas it was necessary to have either 1, 2, and 3 Capri or 1 and 3 Capri, the Simmon's Capri carries the wasp by itself. In the time-table following, the dates of the issue of the wasp are approximate: the date given being that on which the maximum of emergence has been observed. In reality the wasp issues in increasing, and then diminishing, quantities, as the crop gradually ripens and drops. The spring crop of Capri (or Profichi) burst out with the leaves in August; it is ready for caprification in September and is ripe in December. The wasp from this crop is coming out at maximum rate on 20th December. The summer crop (Mammoni) burst out in November; it is ready for caprification in December (from Profichi crop), and is ripe in March. The wasp from this crop is coming out at maximum rate on 12th March. The winter crop (Mammae) burst out in February, is ready for caprification in March (from Mammoni), and is ripe in September, and wasps from this crop caprify the spring or Profichi crop.

Capri figs, like the Smyrna figs, require cross-fertilisation, and the winter crop falls immature unless visited by the wasp. When a fig wasp enters a young fig it leaves its wings at the eye of the fig caught in the close scales at the eye. These can be seen, and makes it easy to judge whether the transference of wasp from Capri to Capri, or Capri to Smyrna, has been successful. Lest it should be thought that the culture of the Smyrna fig requires a good deal of technical knowledge, let me say in conclusion that from time immemorial the ignorant Turks and Syrians of Asia Minor have successfully cultivated and dried this fruit. Once the fig wasp is established, as it undoubtedly is in the Capri fig trees in this State, the remainder of the work is easy and natural. The production of the figs both in Capri and Smyrna at the right time, is a never failing seasonal occurrence. Even if the winter frosts at some time remove the figs from the Capri trees, the wasps are easily renewed by a fresh supply of figs from some adjacent district. Western Australia with its rainfall, free open soil, and its long summer is wonderfully adapted to the natural drying of fruit and will, without doubt, produce a fine quality Smyrna fig.—Journal of the Department of Agriculture, Western Australia, Vol. I. No. 4.

CHERRY TREES ON JAPANESE MAZZARD STOCK.

Mr. S. A. Thornell, Fruit Inspector in the Young district, writing of cherry trees worked on the Japanese Mazzard, said that this stock is to be found in at least two orchards at Young, but the trees are not yet in bearing. Some four-year-old trees of Burgdorf Seedling worked on Japanese Mazzard in one orchard are dying. The scion has outgrown the stock and has apparently suffered from an insufficient flow of sap. For this reason Mr Thornell does not favour the stock in the meantime.—The Agricultural Gazette of N S.W , Vol. XXXV. Part 4.

SOILS AND MANURES

COVER CROPS.

T. D. MARSH.

The following lecture by Mr. T. D. Marsh appears in "The Planter" for December, 1924.

The practice of growing cover crops has no doubt originated from the system of improving land by "green manuring."

Green manuring is practised throughout the world in all kinds of agriculture, and is one of the most economical means of improving soil fertility. The method usually adopted is to sow a quick growing, short lived leguminous crop; one which produces a large bulk of green material, and to plough it under when it is about in the flowering stage. The land is thereby enriched both mechanically and chemically.

The growing of green manures and the subsequent operations are hardly necessary for the successful growth of the principal crops cultivated in Malaya. I do not think they are economical, because of the heavy cost of changkolling necessary when sowing and turning the crop under, but probably are so on such impoverished areas as old tapioca, pine-apple, or such worked out land; it is no doubt quite an economical proposition in more intense forms of agriculture or horticulture.

In the place of green manuring, a much more suitable method of retaining fertility, and improving it, has come into practice in the growth of cover crops—although the system of "covers" is not so "complete" as green manuring, it gives us other benefits.

In green manuring we get almost immediate benefit in enrichment of land, chemically and physically, but in the growth of the covers we may only get half the good results for two or three years, because the covers are growing vigorously. They are not dying or decaying, and until the whole or part of the plants do so, the chemical enrichment of the soil is delayed, and in the early stages of growth they are in competition with the main crop for food material. But they (the covers) are doing good in other ways, which I will now explain.

The benefits to soil by the growth of cover crops are as follows:—

(1) They conserve moisture during droughts by preventing evaporation from the surface of the soil, and in so doing they keep the land from becoming baked and hard.

(2) They improve the physical properties of all soils by the addition of humus, or organic matter. Humus makes clay soils more open, and of lighter texture, and prevents these soils from drying out into hard lumps, as may be illustrated by the case of cultivating and weeding newly opened-up areas, compared with land that has been cultivated for a few years, in which the organic matter has been practically all decomposed.

Sandy soils are made firmer and more retentive to moisture by the addition of humus.

(3) Cover crops prevent the loss of plant food by drainage by taking up the food in the drainage water for their own use, chiefly from the lower levels of the soil, and on their death and decay, these plant foods are liberated for the use of the main crop. This may be specially noticed on hill sides, where the usual methods are employed to retain surface soil from being lost by erosion, by silt pits, terraces, etc., but the water. filtering through these pits, terraces, etc., carries into the depths of the soil. proportionally, large quantities of plant food, and we find the main crop probably rubber, making bad growth, poor bark renewal, and altogether not looking vigorous; principally due to the loss of this plant food being carried deep into the earth and lost to the crop. The remedy is to grow covers, preferably deep rooted ones, for the above-mentioned reason.

(4) Covers prevent the loss of surface soil by erosion on hill sides and are recognised as one of the best means of doing this.

(5) They collect and fix nitrogen from the atmosphere. It is almost essential that covers from the natural order *Leguminosæ* should be grown, as they accomplish all the physical benefits obtainable from non-legumes and in addition they improve the fertility of the soil chemically by the addition of nitrogen. Nitrogen is the most expensive manurial constituent that we have to buy in artificial manures.

Plants of the family of *leguminosæ* can be recognised by their characteristic, legume or seed pod, and are found in the form of creepers, shrubs and trees. They are distributed from the Equator to the fringe of vegetation in the Polar regions.

It was found by early scientists that this order of plants did not impoverish the soil, but on the contrary enriched it, and furthermore they had a higher content of nitrogen than other plants. Consequently the investigators set to find out the reasons. On the roots of these leguminous plants are found nodules. They are really small tumours caused by a colony of bacteria which set up an irritation causing the nodule—the bacteria parasitically living in these nodules have the power of taking nitrogen from the atmosphere for their own use; incidentally, they pass some of it on for the use of their host; the bacteria and host really live together for mutual advantage. When the plant dies, this accumulated nitrogenous matter is left in the soil, and on decomposition it becomes available for the use of other plants.

(6) They decrease the weeding costs, which may amount to a considerable expense in young clearings.

COMMON ARGUMENTS AGAINST THE PRACTICE OF GROWING COVERS.

(a) Slower growth of main crop when under cover crops in comparison with clean weeding.

(b) Difficulties of detecting harmful weeds, such as lallang, and the expensive cost of eradication when found.

(c) The faster spread of root disease, principally Fomes, under cover crops has been noticed both on rubber and coffee, especially on land with much dacaying timber lying about.

(d) There is the danger of accumulation of too much organic matter in coconut areas, providing breeding places for the coconut beetle.

It is by far the best plan if covers are established on newly cleaned land, and before the rubber is mature.

The plants should spread over the ground in the shortest space of time, that the weeding may not be costly during their establishment. With most covers it is necessary to weed for a few months.

The land should be clean and the seeds sown at the beginning of the rainy season.

Covers should provide heavy shade and not grow too tall or woody.

Java agriculturists are recommending the planting of two or more cover crops together. It has been found that each cover appears to do better than where grown alone, a thicker and more airy crop is obtained and if one cover dies, say from disease, the other quickly takes its place.

It is difficult to establish covers in old rubber, or on badly washed hill sides, and the latest method in Java is to scrape to a small ridge running between the rows of trees surface soil, consisting principally of leaf mould, and sow the seeds in the ridge, where the cover becomes established and gradually spreads over the rest of the ground.

Another method is to plant the seeds with a very small quantity of nitrogenous artificial manure or a handful of cattle manure just to give it a start.

The best advice I can give is to try in small plots the most likely covers to be successful and afterwards to establish the best in larger areas.

I understand that in Java and Sumatra it is more the exception than the rule to see estates without covers and they are strongly recommended by all the leading investigators of the D.E.I.

I would advise planters to keep an eye open for any vigorous growing creeping plant (legumes) growing on or around their estates and try them as covers; this is the way most of the covers have been obtained and one may find a cover to suit one's own conditions better in this way than by importing plants from other districts or countries.

It is often advisable to grow one of the less popular covers, such as the *Tephrosias*, which are tall growing, but will do on poor land to get the soil in better condition and afterwards to grow another low growing and better cover.

I do not altogether condemn the non-legumes. Often they will do well where legumes are difficult to grow, or they will give a more luxurious growth than legumes, and although not giving the full benefits that can be derived from legumes, they are undoubtedly very good.

In conclusion, I would say grow cover crops on good land to retain the good qualities and on poor land to improve it, both chemically and physically, and grow legumes.

A FEW NOTES ON SOME OF THE POPULAR COVERS.

Centrosema Plumieri.—One of the most popular covers in the East. Must be established soon after burning jungle. Will not grow on poor soil, and almost impossible to grow on washed hill sides. Is difficult to establish

under old rubber. It can be established on poor soils by sowing the seeds say a yard apart each way, in holes in which a handful of cattle manure has to be placed, but if this cover is not established in the early years of growth of rubber it is better to plant something else—it is liable to die out in patches from the effect of eelworms.

It will grow under old rubber if established early.

Centrosema Pubescens.—At present, another cover I will mention is the most talked of cover in Malaya, Java and Ceylon. It has been boomed in Java and spoken of very highly.

It is reported to resist heavy rains and long droughts—suits heavy but not water-logged soils. It resists shade when established and it is advisable to plant it where trees have been removed or with a handful of cattle manure to get it established. In young rubber it is considered in Java to be the next best cover after Limosa.

Requires clean ground for sowing and wants care for some months in weeding, etc.

It is recommended in Java to give it a chance to climb by placing branches or bamboos where the plant is growing. This facilitates weeding and encourages it to seed.

Vigna Oligosperma and Dolichos Hosei.—Believed to be one and the same plant. Greatly boomed in Java. I am afraid it is not so successful here. The former appears to be more vigorous strain of the plant than the latter. Will withstand heavy shade. Regarded as second to none as a cover crop in Java.

It provides a dense carpet-like cover over ground and absolutely prevents wash on hill sides on clay soils. No records available on sandy or light soils.

Grown very extensively in Java and Sumatra—becomes established in six to eight months—requires weeding until that time. Propagated from cuttings, although it seeds to a small extent if encouraged to climb. Plants may be planted about 2 ft. apart each way.

Calopogonium Mucunoides.—Is a new cover from Java, being tried at Serdang Government Plantation. It is said to be very good.

Tephrosia candida, purpurea, noctiflora, vogelii.—All leguminous shrubs. Have very high manurial content in leaves and branches. Not very popular here, but used extensively in some places. Very useful as shade for coffee plantations, periodically pruned—prunings cover the ground, providing a mulch.

Sown in rows 2 ft. apart, *Purpurea*, which is smallest, requires sowing closer.

There is a doubt as to some of them having poisonous properties to stock.

Suitable for young rubber.

They prevent wash less efficiently than the creeping covers.

Are used where it would be difficult to establish some of the creeping covers: that is on poor soils.

Crotalaria striata, Juncea angyroides, usaramoensis.—Similar to the *Tephrosias* in many respects. Are leguminous shrubs of high manurial value. Do not live so long as *Tephrosias*. Very quick growers. *Angyroides* grows to 10 to 14 ft. in six months.

Cassia Mimosoides.—Similar to *Tephrosias* and *Crotalarias*. Not a success at Serdang—became infected with a beetle which killed it out.

There are many others, principally of the shrub variety. Popular non-legumes are Passiflora, passion vine, sweet potato.—The Planters' Chronicle, Vol. XX. No. 6.

THE CHEMICAL ANALYSIS OF SOILS.

R. MENENDEZ RAMÓS,

Director, Insular Experiment Station, Porto Rico.

The importance of the chemical analysis of tillable soils is already recognized by nearly all the cane growers of Porto Rico, and this is, undoubtedly, helping a great deal toward a more economic and reasonable use of fertilizers, so necessary for the raising of remunerative crops. Nevertheless, it is to be noted that not all the farmers who wish to have their soils analyzed have a precise and clear idea of the role that the chemical analyses play in relation to the study of the proper fertility, and of the requirements of fertilizers for the different soils. Generally too much emphasis is placed on the chemical composition of the soil, that is, it is expected that the most appropriate fertilizer formula for such and such a crop can be readily given as the result of the analysis of the soil. This is only partly possible. The chemical analysis alone is not always the determining factor to indicate the real fertility of a soil. There are many factors to be taken into account, and they all must be considered before passing judgment on the productive value of any soil.

DETERMINING FACTORS OF FERTILITY.

The necessary conditions which contribute to the nutritive elements in the soil to make it productive, are: a proper physical condition, sufficient moisture, aeration, the presence of beneficial micro-organisms and fungi and the absence of injurious substances and organisms. A soil may be chemically fertile, that is, it may contain the necessary amount of all the plant food elements, yet it may produce very poor crops. This may be due to its not being sufficiently permeable and porous or to the lack of the proper amount of moisture, or to the presence of injurious organisms or poinonous substances. Every one of these evils might have its separate remedy outside of the chemical composition indicated by the analysis.

PLANT FOOD ELEMENTS.

Before going any further with discussion of the importance and limitations of the chemical analysis, we must review briefly the nutritive elements which make up the food of plants, since this will aid to a better understanding and interpretation of the soil analysis.

Most authors have fixed the number of elements necessary for plant growth as thirteen. These elements are the following: carbon, oxygen, hydrogen, potassium, calcium, magnesium, iron, sulphur, nitrogen, phosphorus, silicion, sodium and chlorine. Some investigators also include flourine and manganese. Out of these elements there are ten which are

essential for the normal development of crops. They are: carbon, hydrogen oxygen, phosphorus, potassium, nitrogen, sulphur, calcium, iron and magnesium.

If we take into account that nearly 75 per cent. of the weight of green plants is water and that of the 25 per cent. dry matter 11 per cent. is carbon, 10 per cent. oxygen and 2 per cent. hydrogen, we cannot help but notice the small amount of mineral elements which enter into the composition of plants. This small percentage of mineral matter, or ash, is, nevertheless, of capital importance for the perfect development of plants. It is a fortunate thing that these nutritive elements are necessary in such small amounts, since this fact makes the economic replacement of these necessary elements possible in the form of commercial fertilizers.

The fact that the ash content of plants is so small compared with the organic elements, was enough to make the first research men believe that plants did not need mineral elements and that only water and organic substances such as humus, animal manure, etc. were the sources from which the roots of plants extracted their food. Less than a century ago (1840), Liebig advanced the theory that plants were fed from mineral salts that are present in the soil. In spite of the fact that Palissy, Tarello, Von Helmont and others before him had upheld these and similar principles, he, by the force with which he upheld his theories, is to-day rightly recognized as the founder of Agricultural Chemistry. The experiments of Wiegman and Polstroff proved that ash cannot be produced by plants unless they take it from the soil.

All this knowledge is evidently fundamental and on it is based the modern practice of putting into the soil by means of fertilizers the mineral elements which it lacks or that have been extracted from it by the plants.

IMPORTANCE OF THE CHEMICAL ANALYSIS.

The role played by the chemical analysis is, therefore, of great importance. Knowing the quantitative composition of the ashes of a plant and the quantity of vegetative growth (roots, stems, leaves, and fruit), made on a given plot of land, it is an easy matter to figure out the weight of each of the mineral elements extracted by the plant per acre. Besides, the analysis has pointed out to us that not all plants utilize the most necessary elements,—nitrogen, phosphorus and potassium—in the same proportion, a fact that must be taken into account in restoring the various elements that will be taken from the soil by the various crops.

The study of the chemical composition of soils is naturally the outcome of the facts already stated. Once settled, the fact that the mineral substances that make up the ashes are extracted from the soil, it is naturally important to know the relative richness of the soil in these nutritive substances. The chemical analysis will furnish us that knowledge. The practical difficulty lies in the interpretation of the laboratory data and in the proper recognition of its limitations.

LIMITATIONS OF THE CHEMICAL ANALYSIS OF SOILS.

It is true that Agricultural Chemistry has progressed greatly during the last few years, but it really has a long way to go as yet. As long as it deals with the total quantity of an element in the soil the analysis can

be taken as it reads, but as soon as the factor of availability is introduced with reference to nitrogen, potash or phosphoric acid, the analysis ceases to be quantitatively exact and is only approximate. Of course, this cannot be blamed to lack of exactness in the analytical balance, nor to the inaccuracy in the titrations. The problem is quite different.

In spite of the wonderful progress that Analytical Chemistry has made during the last few decades, the laboratory has not as yet been able to imitate nature to perfection and duplicate the action of the roots of plants in taking from the soil the plant food elements. In doing that, we meet with very serious difficulties. In the chemical laboratory we can dispose of several solvents: water, water charged with carbon dioxide, organic and mineral acids, alkaline solutions, etc., etc., with perfect control of temperatures, and of suitable periods of time. A soil sample, after being pulverized and submitted to digestion, furnishes us when analyzed with the percentages of nutritive elements soluble in water or in acid, percentages that often differ greatly from those which the root secretions of plants are able to dissolve.

The process of dissolution which takes place in the laboratory preceding the chemical analysis is naturally more forceful and more rapid than the one constantly going on in the soil. The water present in tillable land, carrying small amounts of carbon dioxide or of mineral and organic acids, reacts in a very mild and variable way on the soil particles. The carbonic acid secreted by the root hairs or plants is only one of the agents which aid in the dissolution of the plant food elements. These reactions to the root secretions are not uniform. We must also remember the bio-chemical changes produced in the soil through the action of micro-organisms, which at times, and especially in a tropical climate like ours, are of capital importance. It is not, therefore, to be wondered at that the results obtained in the comparatively crude chemical analysis are only approximate, when taken in consideration with the solubility in the field of the various plant food elements, and in relation to their probable availability by the plants. Our methods of analysis are very far from duplicating exactly the slow process that, with the aid of the different natural factors, are continually carried on in the soil.

Nevertheless, the wise use of laboratory information concerning the chemical composition of a given soil may be of great utility to the farmer. If the soil is chemically fertile and still does not produce good crops, the problem is then one of better cultivation, of irrigation or drainage, of lack of adaptability by the plant to the environment, or of some other factors. If the chemical analysis shows that the potash content, for example, is so small as to be deficient under all conditions, then the addition of a potash fertilizer is justified. It is recognized that the amount of this or of any other nutritive element to be used depends also on the kind of crop that is to be grown. Sugar-cane, for instance, does not require proportionally such a large amount of potash as sweet potatos. For this reason and for the best use of analytical data, the Insular Experiment Station requires that there be sent in with every sample of soil all the information possible concerning it. Only with the aid of all this collateral information can

the recommendations be made for the formula of fertilizer which it is believed will give the best results for the culture of a certain crop. The farmer who sends a sample of soil to our laboratories and, without any further information, asks what fertilizers be recommended for it, is asking a service which it is impossible for us to render.

Personally, whenever we have to answer inquiries concerning the fertlizer formulas to be used in any case, we are very careful to explain that these recommendations are only approximate and, thus, tentative. We firmly believe that the only safe method to prove what fertilizer formula will give the best results in a given soil is that of establishing small experimental plots and to apply to them those fertilizer formulas which according to the chemical analysis of the soil should be expected to give better results for a certain specific crop. These experiments in the field may be of great profit, especially in the large sugar-cane plantations, where the same kind of crop is to be grown again and again on the same extensive areas. The chemical analysis of the different types of soils would be very useful to indicate to us what fertilizer formulas are probably necessary, but at the end of the experiments we will often find that one of the "probable formulas" has given much more superior results to others, also classified as such previously.

It is evident, therefore, that the chemical analysis is not an exact standard by which to predict the one fertilizer formula that will give the best results. The greatest advantage of such analytical data will be obtained by the cane grower who, recognizing the worth of the chemical analysis of his soils and the aid that this may lend him, understands at the same time its judicious limitations.—The Louisiana Planter and Sugar Manufacturer, Vol. LXXII. No. 26.

ARTIFICIAL FARMYARD MANURE.

With reference to the article on Artificial Farmyard Manure in the *Tropical Agriculturist* for December, 1924—pages 343 et seqr. and to the article on Mauritian Pen Manure which appeared in the number for November, 1924, our attention has been drawn by Mr. E. H. Richards, the Managing Director of Adco Limited that there are a number of points which require some modification. The experiments of Dr. Hutchinson and Mr. Richards at Rothamsted are being continued, and it is hoped to publish the more useful results in a further paper at an early date.

THE VALUE OF PHOSPHATES.

Phosphoric acid is a most important substance in animal nutrition. In combination with lime and magnesia, it forms 85 per cent. of the ash of bones, and the ash of muscular and nervous tissue contains approximately 35 per cent. of phosphoric acid. All tissues provided for the maintenance of the young are very rich in phosphorus, *e.g.*, eggs, milk. Experiments carried out have demonstrated that wherever phosphoric acid is applied artificially there is a substantial increase in the phosphate content of the herbage. It follows then that the top-dressing of pasture lands with liberal dressings of water-soluble phosphates brings about a marked increase in the phosphate content of the grass, clovers, etc., grown on that soil and an improvement in the health of the animals grazing on that pasture.—Journal of the Department of Agriculture, Western Australia, Vol. I. No. 4.

PESTS AND DISEASES.

COFFEE BERRY DISEASE.

J. McDONALD,

Mycologist, Kenya Colony and Protectorate.

As a result of investigations carried out during the past two years, the Coffee Berry Disease has been definitely proved to be caused by the fungus *Colletotrichum coffeanum* but of a different strain from that which is commonly distributed throughout the coffee-growing districts of the Colony where on the whole it does little harm.

The possibility that insects by injuring the berries might be directly associated with the dissemination of the disease has been kept continually in mind during inspections of diseased plantations but no injurious insect has been found at all consistently in the affected district.

Spraying experiments on a small scale and the larger operations of certain settlers have provided valuable information during the past season. Recommendations based in part on this information are included below.

Observations made during Plantation Inspections 1924.

The amount of Berry Disease was, on the whole, appreciably less in 1924 than in 1923.

Rainfall above the average for the month undoubtedly gave the disease an early start in February. Unusually dry weather in June checked it temporarily but the heavy rain of following months was very favourable to the fungus. On the whole, therefore, weather conditions were not greatly favourable to the coffee in 1924 than in the preceding two years.

Badly kept plantations were much fewer than in the previous years and the bushes generally appeared much healthier.

Spraying with Bordeaux or Carbide Bordeaux Mixture had been carried out on a number of farms, usually however only once. In one or two cases two sprayings had been done over part of the coffee and in one or two cases the operation had been carried out three times over a small area.

From observations made on the spot and from settlers' own reports it is evident that one spraying if done thoroughly has a beneficial effect on the health of the trees and is very effective in reducing the amount of Leaf Disease. It is not considered, however, that one spraying is sufficient to control the Berry Disease.

Information received from Planters at end of 1924 Season.

A circular letter sent recently to a number of settlers who had done spraying produced four replies.

The chief points are summarised as follows :—

Farm A. (This farm has never been more than slightly affected with Berry Disease.) All coffee sprayed once between January and April 1924, part sprayed second time in April, part sprayed third time in April. Carbide Mixture used. Marked decrease in Leaf Disease. No opinion on effect on Berry Disease.

Farm B. No spraying in 1923. 40 acres sprayed once, worst affected parts sprayed twice in 1924. Carbide Mixture used. Almost whole plantation affected in 1923. Very little disease seen in 1924. Crop in 1924 100% increase over 1923.

Farm C. 70 acres sprayed once July-August, 1923, once March-June, 1924. 60 acres sprayed once May, 1924. 70 acres unsprayed. Carbide Mixture used. All sprayed coffee looking well. No diseased berries noticed after September. Diseased berries picked off each month. Unsprayed coffee largely defoliated and suffering from Dieback but giving fair crop. Estimated increase of crop 600% over 1923. Manager intends spraying whole plantation three times if possible in 1925.

Farm D. No spraying 1923. 50 acres sprayed once, 10 acres twice, 10 acres three times in 1924. Part unsprayed.

Half strength Bordeaux Mixture used. Where unsprayed no difference in amount of crop between 1923 and 1924. Where sprayed increase of 800%. Coffee looking best and cleanest where sprayed three times.

MISCELLANEOUS OBSERVATIONS.

Coffee Berry Disease was found to be very scarce on one plantation where the cores of maize cobs had been dug in together with an application of farmyard manure.

Spraying with Carbide Mixture in some places appeared to have an effect similar to that of shade, the trees being less affected with "Black Tip" and the leaves more robust in appearance.

One settler reported that ripe berries on sprayed bushes could be left longer without turning to buni than could those where spraying had not been done.

RECOMMENDATIONS.

(1) Everything possible should be done to promote the health of the coffee bushes. Weeds should not be permitted to become rank. If it is impossible to keep them in check during rainy periods they should be removed at ends on the advent of dry weather. A proper system of pruning to promote vigorous growth should be carried out.

(2) All dead branches and berries should be removed and burnt. It is very inadvisable to return diseased pulp to the plantation.

(3) Spraying should be carried out thoroughly using either Bordeaux Mixture or Carbide Bordeaux Mixture. Burgundy Mixture and Lime Sulphur were tried during the past year but for various reasons are not considered so suitable as the two recommended. If possible three sprayings should be done. It is considered advisable to complete the first spraying before February because in the event of considerable rain at that time the disease would get an early start. The two further sprayings should be completed, as weather conditions permit, by July in preparation for the normal heavy rain of August.

If three sprayings are carried out at the times indicated above it is considered that it will be sufficient to use the half strength sprays given below. If less than three sprayings are done, full strengths should be used (*i.e.* double quantities of chemicals to the same amount of water.)

Carbide Mixture (½ strength.)

Bluestone (Copper Sulphate)	...	...	...	2 lb.
Calcium Carbide		...	...	12 oz.
Water	...	...	...	40 gallons

Bordeaux Mixture (½ strength.)

Bluestone	...	...	...	2 lb.
Quicklime	...	...	...	2 lb.
Water	...	...	...	40 gallons

To make *Carbide Mixture*, dissolve up the Bluestone by suspending it overnight in sacking in the water. When solution is complete add the carbide slowly, with constant stirring and out of doors.

To make *Bordeaux Mixture*, dissolve up 25 lb. Bluestone in 25 gallons water in a barrel and in another vessel, carefully slake 25 lb. Quicklime with 25 gallons water. This gives two stock solutions from which the Mixture can be made up as required as follows:—Take 2 gallons Bluestone solution and dilute to 20 gallons in a wooden vessel. In another vessel place 2 gallons lime solution and dilute to 20 gallons. Then pour the two together slowly into a 40 gallon barrel. This gives 40 gallons Bordeaux Mixture of the required ½ strength. It should then be tested to ensure that no free Bluestone remains. This can most conveniently be done by dipping a bright knife blade into the liquid when the presence of free Bluestone will be indicated by a deposit of Copper on the blade. If this occurs more lime solution must be added, otherwise the spray is fit for use. The spray deteriorates on keeping and should therefore be used at once. Spraying should be carried out with the finest nozzle obtainable.

Experiments have also been carried out in the hope of finding a suitable "Sticker" to increase the adhesive powers of the spray in heavy rain. Only one such was found but its cost was considered prohibitive.

COST OF SPRAYING.

From figures supplied by three different planters the following approximate estimates have been made of cost per spraying per acre in affected districts of the Uasin Gishu Plateau. The figures include the cost of labour but do not include any allowance for cost or depreciation of spaying apparatus and the assumption is made that the materials used are imported in bulk by the farmers' organisations.

Bordeaux Mixture Full Strength Shillings	14/40
Bordeaux Mixture Half Strength Shillings	9/10
Carbide Mixture Full Strength Shillings	15/80
Carbide Mixture Half Strength Shillings	9/80

The Farmers' Journal, Vol. VII. No. 1.

SEED-BORNE DISEASES.

PROF. S. F. ASHBY, B.Sc.

It is well known that a number of injurious fungous and bacterial diseases can be and have been introduced into countries and spread in them by means of living plants and their vegetative organs used for propagation. On account of this risk many civilised countries prohibit the import of such material or subject it to careful inspection and disinfection. The trade in seeds for propagation, on the other hand, has been allowed to go on to a large extent unrestricted partly owing to the difficulty of disinfection without seriously impairing germination but also because it was not generally known

that highly injurious fungous and bacterial diseases could be commonly transmitted in or on seeds. The smut diseases of cereals were a recognised exception but effective means had been found of disinfecting seed contaminated externally by smut spores and even seeds where the infection was internal, and the treatment had become a part of agricultural practice.

Of recent years, however, investigation has steadily increased the number of diseases of cultivated plants transmitted by seeds and according to Dr. C. B. Orton, the American Phytopathological Society and Crop Production Institute have compiled a list of at least 160 fungous and bacterial diseases now known or strongly suspected to be carried by seed. The United States Quarantine Act of 1919 was the first attempt to impose interstate restriction on the free movement by the mails of seeds infected by certain diseases. It is probable that such restriction will be extended and become international in scope. It is certain, if not in every case formally proved, that the great majority of the fungous and bacterial diseases of cultivated plants propagated by seed have in the first instance been introduced, into territory not previously infected, by means of seed. A number of bacterial diseases have been and are still being spread by means of seed, instances being the black rot of cabbage, due to *Bacterium campestre*, the bacterial wilt of maize due to *Aplanobacter Stewarti*, the bacterial blight of cotton caused by *B. malvacearum*, bean blight caused by *B. phaseoli* and other bacterial diseases of legumes, the bacterial chaff diseases of wheat and oats due to *B. translucens*, stripe or streak disease of the tomato and legumes due to *B. lathyri* and the bacterial wilt of many crop-plants due to *B. solanacearum*. After introduction on seed some of these parasites persist in the soil and can be more or less successfully controlled by rotation of crops. The number of parasitic fungi transmitted by seed is much greater, instances being the anthracnoses of beans and cotton caused by species of Colletotrichum, the fusarium wilts of cotton, tomato, cabbage, flax, cucurbits and various legumes, most of the smuts of cereals, stripe diseases of cereals caused by species of Helminthosporium, Diplodia and Fusarium diseases of maize and many other fungous diseases. None of the bacteria pathogenic to plants forms spores, so that they are readily killed by suitable germicides when present externally on the seed coats. It is, however, probable that some are carried within the integuments of the seed and are therefore, not wholly accessible to surface disinfection. The evidence to hand indicates that the bacterial blight of cotton is carried externally so that by suitable surface disinfection cotton seed can be freed from it. A number of the fungous parasites may be present externally as spores or internally as mycelium or spores so that surface disinfection of seed may give only partial control; this is true of some smuts, the anthracnoses of bean and cotton and the fusarium wilt of cotton, a disease which for some reason is rare in or absent from the West Indies where banana wilt due to a very closely related fusarium is widely distributed. A recent outbreak of fusarium wilt or 'yellows' of cabbage in Trinidad was introduced with foreign seed and doubtless the bacterial blights of cotton and beans and bacterial wilt of tomato have been introduced into the West Indies in the same way. It is also certain that many other bacterial and fungous diseases of cultivated plants have been introduced and are being constantly re-introduced into tropical countries with seed from temperate lands.

Some of the virus or mosaic diseases are now known to be carried in the seed especially the mosaics of legumes and cucurbits. It is by no means certain that the mosaics of some other crop plants are not occasionally transmitted by seed. Mosaic of the Irish potato has not hitherto been regarded as transmissible by the true seed but at the Botanical Conference in London in July Dr. Salaman adduced evidence indicating that about one seed in a thousand from affected plants may carry the virus. In regard to surface disinfection of seed sulphate of copper and formaldehyde have been widely used in practice for many years against bunt of wheat and the smuts of oats and barley. In India even the small cultivators treat the seed of sorghum (jowar) with sulphate of copper against smut; thanks to the initiative of Government this germicide can be obtained in small amounts by the ryots of every village in districts where this grain is grown. Recently, especially in North America, the sprinkling or steeping of the grain has been giving place to powdering with dry carbonate of copper an easy treatment which has given excellent control of smuts. The Braun method of pre-soaking in water before treatment with formaldehyde has overcome the reduction in germination of seeds sensitive to its vapour such as wheat. Quite recently the chemical manufacturers in Europe aided by their research chemists have offered to the farmer number of a new and powerful seed disinfectants among which uspulun and germisan have been widely tested and reported on favourably. Seeds which carry infection internally present a more difficult problem. In the case of certain cereal smuts which are carried by the seed as internal mycelium the Jensen hot water treatment developed many years ago has proved an effective control; this treatment takes advantage of the fact that the embryo is more resistant to heat than the mycelium of the fungus. Some seeds can be effectively disinfected by dry heat at atmospheric pressure usually at the cost of reducing germination appreciably. It has, however, been shown that cotton seed if thoroughly dry retains its viability unimpaired when exposed to a temperature of over 100°C. in a vacuum or in an atmosphere of an indifferent gas such as nitrogen or argon; in the presence of air the oil is oxidized at high temperatures and germination prevented. Even at tropical temperatures cotton seed rather rapidly loses in vitality unless it is dried well and stored in a dry place. It is evident that seed disinfection is now receiving greatly increased attention and that effective and practical means will be found of rendering innocuous most of the more injurious infections transmitted on or in seed.—Tropical Agriculture, Vol. II. No. 1.

COCONUT FALL.

MELVILLE T. COOK.

In December of 1923 the attention of the writer was called to the falling of nuts and leaves from coconut palms. The section in which this disease was discovered contained a very large number of trees and in some places the majority of them were infected.

The symptoms were:—(1) A drooping of the lower leaves which was due to a black decay at the base of the petioles. These leaves drop prematurely.

(2) A premature dropping of the nuts in various stages of growth from the very smallest up to those that were practically mature. All these nuts showed a black discolouration at the base. In some cases this blackened area became dry after the dropping of the nuts, while in other cases it developed into a soft rot. This variation was undoubtedly due to the dry or wet condition. In case the disease did not attack the nuts until they were practically mature, the husk only was infected and there was no loss. In those cases in which the young nuts were infected, they fell before maturity and the losses were very heavy.

(3) The infection was less on the tall than on the low trees. This disease was never observed to kill a tree but loss of nuts was alarming and the drooping of the lower leaves was very unsightly.

An examination of the infected areas showed an exceptionally large amount of litter consisting of old leaves, husks and nuts in various stages of decay.

A study of the deceased nuts showed a very general infection with *Thielaviopsis paradoxa* (De Syner V. Hohn). In many cases pure cultures were secured direct. A study of the litter showed a very general and very heavy infection with this same fungus.

A few months later our attention was called to two isolated trees which were almost ready to bear fruit. These trees were not making a satisfactory growth; the new leaves were not fully expanded and were very much crumpled. These trees were cut and examined. In the first one a very large amount of decay was found in the center of the trunk but none in any other part. The cultures were overrun with saprophytes and very unsatisfactory for study. In the second there was a small streak of decay from the top to the base of the tree. Cultures from this decay gave abundant growth of *T. paradoxa* but it was impossible to determine whether the infection was primary or secondary. This fungus was reported in the 1912 Annual Report of the Porto Rico Agricultural Experiment Station at Mayaguez as attacking the leaves of the coconut palm but no mention was made of its attacking the nuts. It has also been reported from Jamaica as the cause of a disease of the coconut known as "leaf-bitten," but the symptoms are entirely different from those of the disease found here. It has also been reported from Ceylon (Crics. and Agric. Journ. Royal Botanical Garden, Ceylon 4 (1909) No. 22 S. Sundararaman on "The Coconut-Bleeding Disease,". Bul. 127, Agricultural Research Institute, Pusa) as causing bleeding and decay of the trunks of the coconut palm, but no such condition here has come to our attention. It has also been reported from Florida as the cause of a trunk decay (H. R. Fulton, Phytopathology 12: 398-399, 1922). This fungus is also the cause of a root and stem rot of sugar-cane and a fruit rot of the pine-apple. In some parts of the world it reduces the germination of the sugar-cane. It not only causes a rotting of pine-apple fruits but frequently attacks and kills the slips after setting.

Inoculation from pure cultures of this fungus was made on trees in the Station grounds where there was no evidence of the disease. These inoculations were made by drenching the inflorescence and young nuts with water to make conditions as nearly as possible like those following rainfall. Spores of the fungus from pure culture were mixed in water in an ordinary

atomizer and sprayed on the inflorescence and young nuts. This was done about 4 o'clock in the afternoon. In a few days we had a very general infection and falling of nuts from the smallest up to those about one-fourth grown. The symptoms were typical and the organism was very easily recovered from these nuts. No effort was made to disinfect these trees, but the disease disappeared in a very short time indicating that it was controlled largely by natural conditions.

The moist litter in the plantations furnishes ideal conditions for the growing of this fungus and the spores are produced in great abundance and readily carried by wind currents. The greater infection on the low rather than on the tall trees indicates that the greatest source of infection probably comes from the litter on the ground and that the spores of the fungus are carried up by wind currents. However, the reduced infection in the tall trees may be partly due to the drying influence of the sun which would naturally make conditions unfavourable for infection.

An examination of several groves showed that the disease was most prevalent in the presence of moisture and litter. The disease was not found in the interior and in only a few places along the coast.

We did not carry any work for the control of this disease but recommended a very general cleaning up of all litter in the plantations, and a removal of the diseased leaves and nuts so far as possible. The treatment was carried out and in some places the ground has been ploughed. The reports indicate that the disease has practically disappeared.

The writer was assisted in his work by Mr. R. A. Toro and by Mr. J. A. B. Nolla.—The Journal of the Department of Agriculture, Porto Rico, Vol. VIII. No. 4.

POULTRY.

POULTRY FEEDING.

The following extract is taken from the article on "A Guide for Beginners in Chicken Raising" by F. M. Fronda, of the Department of Animal Husbandry, Philippine Islands, in the *Philippine Agriculturist*, Vol. XIII. No. 8.

ESSENTIALS OF POULTRY FEEDING.

Chickens should be given feeds that are nutritious and palatable; they should be neither too bulky nor too concentrated. They should not have any bad effect upon the system of the bird, nor should they impart any undesirable flavour to the eggs. Above all, the feeds should be easily secured and cheap and, if possible, they should be only products and by-products that would otherwise go to waste on the farm. These feeds should be given in the form of grain, either whole or cracked, and mash consisting of finely ground products, fed either dry or wet. The grain feeds furnish the greater part of the carbohydrates and the mash supplies most of the proteins.

WHAT TO FEED.

Table I gives a list of feeds available for poultry feeding in the Philippines. This table was derived from Appendix Tables I, II and III in Henry and Morrison's "Feeds and Feeding," and from various other sources. Whenever possible, the digestible co-efficients for poultry were used, otherwise, the digestible co-efficients for ruminants were employed with the fibre free, in as much as poultry cannot digest fibre. The amount and cost of these feeds vary according to the time of the year and the locality. A judicious selection and a careful combination of such feeds as are available is necessary to feed a flock with profit, as no single feed contains all of the necessary nutrients and accessories in the proportion that is needed by fowls.

Table I.—Showing the average analysis and digestible nutrients in 100 Kilograms of feeds that may be available for poultry.*

Feeding Stuff	Total ash	Total crude fibre	Digestible nutrients		
			Crude protein	N-Free extract	Fat
Corn, cracked ...	1·5	1·5	8·9	63·2	4·3
Corn meal	1·3	2·3	7·0	64·1	3·4
Corn bran	2·4	9·8	5·8	49·9	4·6
Rice, rough	4·9	9·3	4·7	61·4	1·7
Rice polish	4·8	1·9	8·0	56·7	7·5
Rice shorts (*binlid*) ...	2·2	0·8	9·2	71·7	2·0 a
Rice bran	13·2	13·6	6·9	34·1	6·5
Rice meal	9·1	9·3	7·3	44·8	10·6
Sorghum	1·9	2·0	7·5	59·5	2·6
Copra meal ...	7·3	15·7	15·8	35·6	5·8 a
Cowpea	3·4	4·1	19·4	51·9	1·1
Soy bean	5·3	4·3	30·7	19·3	14·4
Soy bean, fat extracted ...	5·4	5·3	38·1	28·7	5·0
Mungo	3·0	4·4	20·4	56·6	0·9 b
Sunflower seed ...	3·1	27·9	13·5	15·1	20·3
Peanut without hull	2·2	2·6	24·1	14·7	40·4
Peanut waste ...	5·4	6·2	22·0	13·0	30·1
Cows milk	0·7	—	3·3	4·9	4·3
Whey	0·7	—	0·8	4·7	0·3
Fish meal	32·0	—	40·9	—	2·2
Dried shrimps ...	19·7	4·2	55·6	3·3	2·6 a
Snails, fresh	6·1	—	7·6	7·3	0·8 a
Fresh bone, ground ...	21·1	—	18·3	—	24·5
Bread	1·5	0·7	5·8	51·5	0·5
Barley refuse ...	5·2	0·5	8·3	60·5	7·0
Cabbage, outer leaves ...	3·1	2·8	1·7	4·3	—
Mixed grasses ...	1·8	10·6	1·7	8·6	0·6
Potato	1·1	0·4	1·1	15·7	—

* Derived from Appendix Tables I, II and III in Henry and Morrison's "Feeds and Feeding," 1917, and from other sources.

a. From analysis reported by the Department of Chemistry, College of Agriculture, University of the Philippines.

b. From analysis reported by the Bureau of Science, Manila.

COMPOUNDING OF POULTRY RATIONS.*

As a general rule, poultry feeding is carried on with one of four productive purposes in view: (1) laying, (2) growing, (3) fattening, or (4) breeding. The ration should be adapted to the purpose, otherwise there will be an unnecessary waste of nutrients. Laying rations should contain more protein than carbohydrates and should be given in form of grain, whole or cracked, and mash mixtures. The growing ration for young chicks is similar to this except that the ingredients are less in quantity and the proportion of both ash and protein is greater. The fattening ration should be in such form, condition, consistency, and palatability as will facilitate consumption of large amounts, and insure rapid digestion and assimilation. This is made up entirely of grain, either whole or ground. The breeding ration, in general, is frequently the same as the laying ration.

HOW TO FEED POULTRY FOR PROFIT.

There is no hard and fast rule as to the particular poultry ration to use. A certain ration found profitable under one set of conditions may be a failure under another, and feeds available and cheap in one region may not be in another. The safest guide is to use whatever feeds are available, the proportion of the different ingredients to be governed according to the object in view.

Feeding the Young Newly-Hatched Chicks.—Hard boiled infertile eggs, chopped very fine, shell and all, and mixed with four to five times its bulk, either of bread crumbs, boiled rice, or rice bran may be given to newly-hatched chicks. This mixture should be given at regular intervals, four to five times during the day, giving only a little at a time. Fine grit, plenty of green feed, and clean cool water should be available to the chicks at all times. This mixture can be fed to them during the first week of their lives, about one egg to every thirty chicks a day.

Feeding the Older Chicks.—A mash mixture composed of two parts by a weight of rice bran, one part of rice shorts (*binlid*), one part of copra meal, and one part of dried shrimps may be given four times a day. If dried shrimps are not available, either ground snails or *anay* may be fed at noon, giving enough to keep the chicks busy for about twenty minutes. Fresh clean table scraps may be used to great advantage. The chicks in addition to this, should be given a chance to run out in the yard as much as possible, and receive plenty of sunlight which is essential for their normal growth.

Feeding the Growing Stocks on a Wide Run.—Young chickens kept on a wide run may be fed either cracked corn or palay or both, and a mash mixture composed of one part each by weight of rice bran, of rice shorts (*binlid*), of corn meal, of copra meal, and of dried shrimps. This mash mixture should be available to the birds all day. If shrimps cannot be secured, some form of meat food as ground snails or *anay* should be given instead. Fresh table scraps may also be given. If the runs have a good vegetation, the chickens may get enough insects, bugs, and worms to supplement the feeds given them.

Feeding the Laying Hens.—A very simple, fairly cheap laying ration,

* In poultry husbandry, the term *ration* usually refers to the composition of the daily diet of fowls.

and one which may be easily secured is :—

Grain : Cracked corn or an equal mixture of corn and palay.

Mash : 2 parts rice bran.
1 part rice shorts (*binlid*).
1·5 parts of copra meal.
0·5 parts dried shrimps.

Where a corn grinder is available, one part corn meal may replace one of the two parts of rice bran. The meat food may be omitted from the mash if it cannot be obtained at a reasonable price and table and kitchen scraps given instead, and enough ground snails to keep the chickens busy for about twenty minutes at noon.

Feed the hens only enough grain to partly fill their crops in the morning so that they will hunt for more out in the run and thus get exercise. Feed the mash in troughs left open all day; if wet mash is given, feed only enough to keep the chickens busy for about ten minutes at noon. Before the birds go to roost at night, give them all the grain they can consume so that they go to rest with their crops full.

It should not be forgotten that laying hens need plenty of clean, cool water. The drinking troughs should be cleaned and refilled at the time the hens are given their morning grain. Green feeds stimulate the production of eggs, and for this reason a good sod around the poultry house is a necessity. A wide grassy run is also necessary, for too close confinement in a barren yard favours a quick souring of the soil and the multiplication and spread of disease germs and parasites.

Feeding for Fattening.—Corn is one of the best grains for fattening chickens. Confine the birds to be fattened in a small pen and give them all the corn grain that they will consume readily. Do not give too much at a time or they will tire of it. Continue feeding them this way until the birds are fat enough to satisfy the feeder.

A mash of equal parts of corn meal and rice bran, moistened to a sloppy condition, is a good fattening feed. Confine the birds in a small cage and fast them for about twenty-four hours before giving them the mash. Soft boiled rice may be added with advantage to this mixture. Chickens may be fattened on boiled rice alone. The birds that are being fattened should not be disturbed, and, if possible, the fattening cages should be placed in semi-dark corners. The birds may become fat in a week, but this depends of course upon the degree of fatness desired. In any case, the fattening process should not last more than two weeks as the birds begin to lose weight after about that length of time.

GETTING HENS INTO LAY.

It often happens that after birds have come through the moult they are a long time coming into lay again. This may be due to one or two causes. It may be found that they have put on a lot of fat through being given food of too starchy a nature and deficient in albuminoids, together with lack of exercise. Fatty tissues retard laying, and such a condition should be remedied without delay. The condition and vigour necessary for egg production will be assisted by the addition of a little salts to the drinking water about every third day for a fortnight, a change of diet and burying all corn in litter.—The South African Poultry Magazine and Small-Holder, Vol. XVIII. No. 155.

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CO-OPERATION.

PROGRESS OF CO-OPERATIVE SOCIETIES IN CEYLON.

The eleventh report of the Registrar of Co-operative Societies of Ceylon on the working of Co-operative Societies for the year 1923-24 has been issued. The movement has made further progress during the year and the report states that further strengthening of the staff was desired in view of the increased demand for the services of the officers of the Department and of the proposed organisation of Central Co-operative Banks. At the present time there are no Co-operative Central Banks in Ceylon and as the number of primary societies is increasing it is very desirable that these Banks should be started at an early date.

Twenty-five new Societies have been registered during the year and the registration of eleven Societies has been cancelled and the increase during the year was therefore fourteen. The total number of the Societies at the end of the year was 222. Most of the Societies, registration of which have been cancelled, are those which have not even begun their work. After

registration, these have been removed for the very good reason as it has been stated that "those Societies which neglect to perform any useful work after registration do more harm than good to the cause of Co-operation." This is a warning to those who enthusiastically get up Societies and neglect to work them up. The number of Industrial Societies increased to 17 from last year. The membership, the paid-up capital, reserve fund and deposits have all increased. There were 23,322 members in all last year and this has increased to 26,757 this year. Of these 1,325 belong to Industrial Societies and the rest to Agricultural Societies. The paid-up capital has increased during the year by Rs. 49,917·52 and total capital stood at Rs. 238.607·02 at the end of the year. The amount due to the Reserve Fund has increased from Rs. 32,142·88 to Rs. 44,603·64. This works out a little less than one-fifth of the Share Capital—a very satisfactory and sound progress in this direction.

Most of the Societies are interested in agriculture and this is quite expected in an agricultural country such as Ceylon. Non-agricultural side has also made some advance. The report records 17 such Societies which have been formed for various objects such as Credit and Supply Societies, Credit and Provident Fund Societies, Weaving Societies, and Societies for fisher-folk and rickshaw men. The majority of these Societies have made encouraging progress.

The loan transactions have also increased during the year and the total lent out this year amounted to Rs. 352,107·17, the total repayments to Rs. 241,343·17 and the total outstanding at the end of the year stood at Rs. 417,906·44. The amount of loans given by Government to the Societies has also increased and the total amount due to Government at the end of the year from Societies was Rs. 49,562·64. This forms an eleventh part of the total working capital of all the Societies. Another important item in the report is the reference made to the increase in cash transactions of the Societies during the year under review. Eleven years ago the figures stood at Rs. 8,202 and last year they were Rs. 396,016 and this year it has reached a little over 5½ lakhs, viz., Rs. 552,153 which means that the transactions have increased to sixty times the figures of the original year.

The progress of the movement in some of the provinces has not been as satisfactory as one would expect it to be. In two of the provinces there has been no increase in the societies. The Western Province had only one new Society. In the Northern Province the number of new Societies is 8. The other provinces have had some new Societies. The paid-up capital has increased in all the provinces and the prospect of the movement in certain provinces appears to be much better.

The Training Classes have been held during the year in several centres and these classes are gaining popularity. Many Societies have sent in representatives to attend these classes and the attendance of the genera public and the minor headmen has been more satisfactory. This will show that the educational side of the Co-operative Movement is also receiving due attention of the Registrar and the general public. A manual on Co-operation has already been prepared and is in the hands of the Printer. This will give the Co-operative worker an opportunity to gain more knowledge on the work so that he may do his work better.

N. W.

GENERAL

THE EXPERIMENT FARM AND AGRICULTURAL PROGRESS.

It is proverbial that in the make-up of the farming community the conservative element holds no small place. The farmer, above all men, is a believer in the wisdom of his ancestors, and he is apt also to think that his inheritance of farming wisdom covers everything that it is possible to know on the subject. But of recent decades all over the world a new spirit has been moving fruitfully in the farming soul. The Man on the Land now admits that much as his ancestors knew about the land and the best means of using it, their knowledge did not embrace everything pertaining to matters agricultural. The Experiment State Farms in Western Australia and in other States of the Commonwealth, and the model farms conducted under the Ministry for Agriculture in Britain are concrete and tangible evidences of the existence of the new spirit, not only of its existence, but of its desire to learn and to profit by learning.

A handful of years ago when the Experiment Farms in this State came into existence, the idea was not received seriously by quite a number of the farmers of the time who were apt to regard it as mere scientific gilt upon the solid body of practical farming. For years the work done at the Experiment Farms attracted comparatively little attention, but to-day things are entirely different. The quality of the work done, and the hard and undeniable evidence furnished by results obtained, have shattered the iron bands of the old conservatism and in Western Australia at least the farmers do not only accord the Experiment Farms their heartiest approval, but they take every opportunity of making themselves acquainted with the nature of the experimental work that is being carried on, and the lessons thus learned they are rapidly applying to their own interests. The farmer of a few years ago who, when he attended a Field Day at an Experiment Farm, was in the habit of regarding the whole proceedings with a cynic humour, has disappeared, and he has been replaced by the farmer who spares no effort to get to the appointed place on the day arranged, well knowing that he will return home with his knowledge of farming matters very materially augmented. The cynic farmer, in short, has gone, and in his stead is the farmer's student, eager, alert and receptive. The new attitude of the farmer towards his own professional preoccupations is one of the happiest omens for the future welfare of the State. Stagnation we know is synonymous with decay, while progress spells material benefit all along the line. In every other avenue of industry, more particularly secondary industry, those engaged in it are always looking out for some means or other that will reduce cost of production or increase the amount and quality of the output, and their attitude in this respect is reasonable. The man who lags behind and does not keep himself well up to date must,

and does, fall back in the race for patronage. Goods turned out by old-fashioned inefficient machinery cost more to produce and are not of the quality of those made by more modern appliances. In the matter of farming, the case is on similar lines. The farmer who does not prepare his land by the methods best adapted to the soil at his disposal, and who does not use the seeds and kind of fertiliser best suited to that particular class of soil, cannot be expected to achieve the same results as the man who has brought expert knowledge to bear upon the question and has conducted his operations along lines that have been proved to be the most effective and productive.

The Merredin Experiment Farm held its Field Day in the middle of October last. The numbers of people who attended, and the distances that many of them came from, and the keen interest that was displayed by all of them in everything they saw are sufficient of themselves to justify to the full the Government and the Department of Agriculture in the course that it has for years been pursuing, viz., that of affording educational information by a telling and indisputable object lesson. Merredin has already dispelled many old and cherished fallacies, and it has also enforced some little known and many new agricultural facts. The new comers from the Old Country—and several of such were present—had an opportunity of seeing some experimental work, the results of which probably shattered some pre-conceived but entirely erroneous beliefs. Quite a number of new settlers from Great Britain are under the impression that seeds that do remarkably well in England must for that reason also do equally well in Western Australia. But the assumption has no solid foundation, for it does not take account of the differences in climatic and soil conditions between the two countries. Not a few new settlers, their English training strong within them, have planted British seeds, and the result has been such as could not do otherwise than convince them that they had fallen into error. Among the many items at Merredin were rows planted with English seed and many new settlers who inspected these rows are very likely to profit by what they saw and to critically revise their pre-conceived notions as to the suitability of old-world seeds for the Wheat Belt of Western Australia. The lesson of the wheat seed plots at the Experiment Farm is too obvious to be overlooked but it is by no means a new lesson, although it is one that has, as yet, only been learned and taken to heart by a moderate percentage of the farmers of this State. Experimental work all over Australia has steadily been increasing the average wheat yield. In Victoria some of the results in this direction have been marvellous. In New South Wales and South Australia also the increase in yield has gone on steadily, and in Western Australia the experimental farm is driving home the same lesson. Much of the comment heard at Merredin at the last Field Day turned on this point. There are many farmers who are unable to increase their acreage, but the Experiment Farm has shown that the limitations imposed by acreage need not necessarily exist so far as yield is concerned. The farmer cannot add another acre to his holding, but by careful selection of seed, and by working his land in the manner that will call forth his highest productive powers, he can, under ordinary climatic conditions, increase his yield. In this matter of increased yield, the agricultural interest is following along the lines of

development that have been traversed by the pastoral industry. The pastoralist of to-day is taking three or four more times the weight of wool per sheep from his flock than was done by his predecessor of an earlier generation. This result has been achieved by careful breeding, feeding and culling, and in the province of agriculture similar care devoted to the selection of the seeds and to the preparation of the field—the cradle of the crop—can give no other than results gratifying to the farmer. Already the work on the Experiment Farms in this State has solved a number of problems that have special interest to Western Australian farmers, and in so doing they are carrying out the Department's objective of always holding out the helping hand to the Man on the Land.

The Minister of Agriculture (Hon M. F. Troy), in the course of his remarks on the occasion of the Merredin Field Day, after referring to the present position of agriculture in this State and the season's prospects, said that in farming, like everything else, the best results could only be obtained by following the best methods. In his view, fallowing and good crops were synonymous terms. It appeared to him that the farmer who cropped on cultivated land was doing something in the nature of courting disaster. It was significant that wherever fallowing was practised the average yield was steadily rising. Wimmera, in Victoria, was an instance in point. Farming on fallowed land was being conducted successfully at Southern Cross, and that fact alone spoke volumes in its favour. In his opinion it would be far better if settlers were to wait two years for a return off fallow than to take a risk on ploughed land. There was sound sense in the Minister's words, and the visitors at Merredin had an opportunity of verifying the fact through the object lesson provided on Field Day.—Journal of the Department of Agriculture, Western Australia, Vol. I. No. 4.

TWO VALUABLE FODDER TREES.

C. T. WHITE, F.L.S.,
Government Botanist.

I have long been of the opinion that one of the surest ways to combat the serious droughts, that Queensland in conjunction with most other parts of Australia periodically suffers, is by the systematic planting of drought-resistant fodder trees. Trees, owing to their extensive and usually deep root systems, once established have an advantage as drought resisters over grasses and herbage. Two trees commonly planted in Queensland gardens as shade trees have been brought under my notice recently as trees of considerable value as food for stock.

One of these trees is the Phytolacca or Bella Sombra trees (*Phytolacca dioica*) and the other the mis-called "Portuguese Elm" (*Celtis sinensis*).

(a) Phytolacca or Bella Sombra Tree (*Phytolacca dioica*).

Description.—A large rapid-growing soft-wooded tree; leaves a rather bright glossy green, long-stalked, the stalk often purplish, lamina or blade of leaf usually oblique at the base, *i.e.*, one side longer than the other. Flowers greenish white in long slender racemes ("spikes") of six to nine

inches or even longer, the male and female flowers on distinct trees. Fruits densely clustered along the spikes, depressed globular.

Native Country.—A native of South America; widely cultivated in the sub-tropics as a shade tree.

Botanical Name.—From the Greek *phyton*, a plant, and the Italian *lacca*, lac or varnish; from the berries or fruit of some species yielding a red colour like lac.

Fodder Value.—In his "Comprehensive Catalogue of Queensland Plants" the late F. M. Bailey remarks, "Cows will devour the stem of this tree when cut down as they do our bottle trees." This, however, is a very wasteful method of utilising a very valuable fodder tree, and I was therefore glad to hear recently from my friend Professor S. B. J. Skertchly of the use of this tree as a fodder at Purga, near Ipswich. I later visited the farm of Mr. Dick, at Purga. Mr. Robert Dick kindly gave the following particulars regarding the methods of using this tree as a fodder. Mr. Dick stated: "As Queenslanders know, nine out of every ten springs come in dry, and our way of helping the calves over the spring is to prune the Phytolacca trees of a few branches every day. These branches are anything up to 12 feet long (one year's growth). Whether dry or not we always prune in the spring to have a strong crop of shoots next year. One cannot grasp the effect of the pruning unless seen. I may say we have known a single shoot of one year's growth to be 4 inches across at the butt, to attain 16 feet in length and to weigh 28 lb.; of course cattle would not eat all of such a big shoot as this, but would eat all the leaves and chew the stem down to about where it was 2 inches thick. These trees make very rapid growth here. A number of young under-hanging shoots are always left to bear flowers and fruits."

As stated by Mr. Dick the tree is a rapid grower.

From the above it will be seen that the Phytolacca is a very valuable tree for planting in Queensland as a fodder.

(b) *Celtis sinensis.* Nettle Elm, mis-called "Portuguese Elm."

Description.— A deciduous leafy tree not usually very tall and with a large spreading head. Leaves glossy green above, somewhat paler beneath, the base usually but not always very oblique (*i. e.*, lopsided), mostly 1½-2 inches long and 1 to 1½ inches broad, borne on a stalk of about one-third of an inch. The edge bluntly toothed in the upper part of the leaf. Flowers insignificant. The fruits are small rounded drupes (berries) borne on slender stalks of about one-quarter of an inch long in the axils of the leaves, yellow when ripe and about one-quarter of an inch in diameter.

Native Country.—China; a widely spread tree in the Orient.

Fodder Value.—Our attention was first drawn to this tree as a fodder by Mr. E. Everett, Inspector of the State Advance Corporation at Gayndah, who, in a letter dated 31st December, 1923, wrote:—

"I would like to draw attention to a splendid fodder tree which grows along the banks of the river at Gayndah and in some instances is used as an ornamental tree. I have been told that the name of the tree is "Portuguese Elm." It sheds its leaves annually but has a most luxuriant growth of leaves

from about October to June, and if these trees were planted along the river and creek banks there would never be any occasion to lose a beast from starvation during those months in the most severe drought. The trees are hardy, but of course require protection until they grow out of reach of horses and cattle. Small trees can be got by thousands under the trees, but cattle and horses never let them grow high when within their reach. I have had experience with Currajong, Oak, and Bottle trees, which will keep cattle alive for a little while, but they will thrive and improve on Portuguese Elm. If any officer of the Agricultural Department passes through Gayndah at any time I should much like to show him these trees and give him any information I possess on the matter."

The point brought forward by Mr. Everett is a very important one, and I fully endorse his opinion that the planting of fodder trees would in the end go a long way to mitigating the losses of stock that occur during every drought period.

Celtis australis is another species that is grown in Queensland gardens but to a less extent than *C. sinensis*. Of *C. australis* Sir George Watt, in his "Dictionary of Economic Products of India," says, "The tree is largely planted for fodder, cows fed on the leaves are supposed to give better milk." The species would no doubt stand greater degrees of cold than *C. sinensis* and would be a valuable tree for the Darling Downs, where some fine trees are already to be found.

Botanical Name.—*Celtis*, one of the names anciently given to the Lotus. Tounfort first applied the name to the modern genus which may be said to resemble both in the fruit and foliage and shrubby Lotus of the ancients (London, Dictionary of plants); *sinensis*, a native of China, from the Latin *sinae*, an Oriental people.

Common Name.—Though the tree is a native of China, in Queensland the tree is known almost everywhere under the name of "Portuguese Elm." This arose, no doubt, from its confusion with another species of *Celtis (C. australis)* cultivated in the cooler parts of the State, and a native of Southern Europe.

Identification of the Tree:—The present tree is common in Queensland gardens and has variously passed as *Celtis australis*, *C. Krausiana* and *C. occidentalis*, but as I could not fit it in with any of these species, I sent specimens to the Director, Arnold Arboretum, Boston, U. S. A., and obtained the reply that the tree was *C. sinensis*, a native of China, and widely spread in the Orient.—Queensland Agricultural Journal, Vol. XXII. Part. 5

PACKING TROPICAL SEEDS.

The following extract is taken from the Department Circular 323 of the United States Department of Agriculture on "How to Collect, Label and Pack Living Plant Material for Long-Distance Shipment" by B. T. Galloway. Office of Foreign Seed and Plant Introduction, Bureau of Plant Industry.

Tropical seeds are among the most difficult seeds to ship long distances. This is particularly true of the lychee, longan, cacao, mangosteen, mango,

and seeds of many palms. The avocado is not so difficult to ship. This seed, being large and almost woody, ships comparatively easily. One of the best methods of making certain the safe transportation of lychee and longan seeds is to ship the fruits containing the seeds. The fruits, if properly packed, will stand four or five weeks' travel. They carry best in fine, dry, sifted sphagnum moss, sifted coconut fibre, or coir, to which has been added a little coarse charcoal. It is not necessary that any of this material be wet or even damp. There is enough moisture in the fruit to serve all practical purposes for successful transportation. Allow enough packing to keep each fruit and each layer of fruits well separated.

Fruits of this nature may be packed in small wooden or tin boxes. The wooden boxes, if sufficiently strong, will need no additional protection. Tin boxes, however, especially if the tin is thin, should be wrapped in several thicknesses of heavy newspaper, then in strong manila paper, and finally covered with a cotton bag sewed on.

Cacao seeds are soft and ferment and mould very easily. To be certain of their viability they must be gathered when fully mature and packed immediately. Coarse charcoal is the best packing material for them. Some of the best results in forwarding these seeds have been secured through sending the entire cacao pod without breaking or mutilating it in any way. The pod contains numerous seeds, and as a rule there is sufficient moisture in it to bring the seed through in fairly good shape. The pods, often measuring 4 to 6 inches in length, should be packed in coarse charcoal, using either strong wooden or tin boxes as carriers. It is the practice of the growers of cacao to forward pods containing seeds after dipping the pods in paraffin. No advantage has been found in this treatment; in fact, paraffined pods seem more inclined to ferment than those not so treated. Plenty of charcoal should be used, in order to thoroughly surround the pod with the antiseptic material.

Of all the seeds in this list, those of mangosteen have proved the most difficult to handle. These seeds are short lived, and for this reason it is difficult to transport them any great distance. The difficulty of transporting the seeds and the fact that most of the usual methods fail in attempts to propagate the plant no doubt account in large measure for its rarity and limited distribution. The mangosteen is one of the most delicious and highly prized tropical fruits. Many attempts have been made to establish it in some of our tropical regions, but with the exception of a few scattered trees there are no plantings of mangosteens on this continent.

The following specific instructions are offered for the securing, handling, packing, and shipping of seed of this fruit, in the hope that with the directions closely followed sufficient live plants may be secured to establish plantations of the trees in our tropical possessions.

Gather and select fully matured and perfect fruits and have everything ready for packing the seeds as soon as they are cleaned and dried. The seeds will dry in a few minutes, and drying should be done very carefully and always in the shade. Be sure that the seeds are plump and sound. Many of the seeds while appearing good are liable to be aborted and will ferment and sour when packed. Coir dust is the best packing material to

use. This is nearly always available in the Tropics, where the mangosteen grows. Charcoal may be used, though it is not recommended unless coir dust is unavailable. The best receptacles for packing are small wooden or tin boxes such as are commonly used throughout most parts of the world for wafers and biscuits. These boxes usually measure 8 by 4 by 4 inches to 10 by 5 by 5 inches. The coir dust should be slightly moistened, and this is one of the difficult features of the procedure. Ordinarily steaming the coir dust for a few minutes or holding the receptacle containing the dust over boiling water for a short time will moisten it sufficiently for all practical purposes. It is best in all cases to moisten the dust several hours or several days before it is to be used. Freshly moistened dust is never so good as that which has stood for 24 to 48 hours. With fresh, clean seeds at hand the coir dust should be spread over the bottom of the box to a depth of half to three-fourths of an inch. A layer of seed may then be placed on top of the packing material and another layer of dust added. This process should be continued until the box is filled. The top layer of coir dust should be rather thick. It is important that the seeds should not come in contact with each other. Good packing requires about twice as much material by volume as there are seeds. When the box is sufficiently packed it should be shaken carefully, in order to have the packing material fill up all the spaces. Fasten the lid of the box firmly, wrap in two or three thicknesses of oiled paper, then strong manila paper; then sew on a cloth covering, as described for other seeds. Follow the same plan of labelling as suggested elsewhere.

Another method of packing mangosteen seed should also be followed in order to make certain of successful shipment. By this method the seed is pre-germinated; that is, it is made to sprout slightly before packing. It has often been observed that mangosteen seeds arriving from the Orient are slightly sprouted. In such cases fermentation and moulds have not attacked the seeds. This suggested the idea of allowing the seeds to sprout slightly before packing. Freshly gathered seeds may be placed in coir dust, coconut fibre, or other suitable material for sprouting, and upon the first appearance of sprouts, which under normal conditions will be in 15 to 20 days, the seeds should be carefully lifted and packed as described above. Packed sprouted seeds grow very little as long as they are in tight boxes, but when removed from the boxes and placed in soil or other suitable material they grow quite rapidly.

Mango seeds need careful handling. They are covered with a fibrous coat to which the flesh of the fruit clings tenaciously. The seeds should be scraped clean and then washed. After drying in the shade they should be packed in dry charcoal or dry coir dust, about as described for the mangosteen.

Avocado seeds may be packed in cut-up straw, fine shavings, sawdust, rice hulls, or grain chaff. Large lots, if going forward by express, may be packed in wooden boxes, using ordinary straw or excelsior for packing material. The chief point to observe in packing these seeds is to fill in sufficient packing material to prevent bruising and drying out. Label and mark as described for other seeds.

CULTIVATION OF PAPAYA.

M. L. JAYAWANT, B. Ag.

This tree is supposed to have been imported from America, judging by its name, shortly after the discovery of that continent. That it did not exist in India before is pretty certain from the fact that the name does not appear in the Sanskrit language.

The Papaya tree prefers a moist warm climate and fruits all the year-round. Propagation is done by seed. Experiments have been started to breed seedless varieties in Poona Agricultural College by Prof. G. B. Patwardhan, B. Sc., F. R. H. S. in the year 1919 and it is believed that the attempts are successful by now.

A curious thing has been noted by Mr. Kulkarin, Lecturer in Horticulture of Poona Agricultural College, in his study of this plant in the Ganeshkhind Gardens ; viz., that the male plant changes into hermaphrodite and subsequently into female. After some time reversion was also noticed.

Propagation by grafting has been attempted in America and Lucknow and it is claimed that plants thus propagated fruit earlier.

The tree generally begins to yield at the end of the first year and continues up to the 4th or 5th year—in some cases more.

Water logging is harmful to the plant primarily because it rots the tender stem. The seeds are grown in pots in May and the young plant begins to appear in 6 weeks. One month later they are transplanted in pits previously dug 2 x 2 x 2 feet and treated with farm-yard manure and litter.

In some cases the litter and the dried cattle dung is burnt in these pits and they are filled with loose black soil. Seedlings are transplanted in June or July when the monsoon sets in.

The following mixture has been found to be the best for fruiting and it also helps to dovelop aroma:—

Superphosphate or Bone meal	100	lb.
Sulphate of Potash or Saltpetre	40	,,
Nitrate of Soda	32	,,
Black Sand	62	,,

This may be applied at the rate of 1 lb. per tree once in the beginning of monsoon and once in October. Care must be taken, however, to see that the plants are not irrigated after they are thus treated. The best way to put the mixture on is two days after showers of rain or irrigation, so that there would be just enough moisture for the fertilizers to act but not to be washed off.

So far as Berar is concerned most delicious papaya fruit has been found to grow in the Khamgaon tahsil. Those that have been bred by Professor G. B. Patwardhan in Poona are not inferior in taste, aroma and flavour. It has been found that the smaller the seed the more is the flavour and taste developed.

Papaya has many uses. The bark is used in the manufacture of ropes. The seeds are reported to have the property of curing worms and also to be useful in female disorders. They are also carminative. The raw fruit contains papain which has the property of digesting meat. The leaves are

used for external applications to remove pain. Water containing juice of papaya leaves is used for bleaching, and removing stains of ink, etc., and also washing coloured cloth, especially black. It brightens the colour and makes it fast.

The milk of raw fruits contains pepsin, which dissolves albumen but not meat. The pepsin proper acts in the presence of acid but papaya pepsin does not and that is why it is not such a strong digestive in the presence of gastric juice. In the presence of alkalies it is a powerful solvent and helps digestion. It is used for reeling silk or tusser cocoons.

Preparation of this product is easy.

The juice should be obtained from fresh young fruits. Moisture and high temperature spoil its activity. The juice should be dried at a low temperature and then immediately mixed with double the quantity of rectified spirit. This mixture should be allowed to stand for several hours. The residue should be filtered off, dried in atmospheric temperature, powdered and kept in an air tight bottle. This has an extensive market. The present supply of papain comes from Ceylon and the West Indies, especially from Montserrat. Meat if treated with fresh juice will cook better and quicker.

Syrup, wines, elixir made from the fruit are sedative and tonic.

The strange and beautiful races of Antilles astonish the eyes of strangers and travellers who see them for the first time. If they are to be believed, the clear and clean complexion and exquisite flesh arise from the use of the papaya fruit as a cosmetic. A slice of the ripe fruit is rubbed over the skin and is said to dissolve spare flesh and remove every blemish.

The most important property of the papaya fruit from a bio-chemical point of view is its power of converting other food into protein. This proteolytic power is possessed by the latex of the fruit.

The unique property of the milky juice of the unripe fruit has attracted the notice of Western Investigators since 1878.

In 1921 experiments were carried out at Pusa. It was found that fruits having 3 or 4 incisions can be made to bleed on subsequent operations after an interval of a day or two but those having 7 or 8 incisions produce nothing when incised again. After rains the latex (juice) was thin and did not coagulate at once. Early morning is the best time to tap.

In preparing the crude papain, the following points should be specially observed:—

(1) Juice should be dried as soon as possible.

(2) In drying, temperature should not rise above 40 degrees Centigrade. Both these ends are obtained in some places by drying on hot plates.

(3) The final drying should be done, if possible, in *vacuo*.

(4) The product should be ground to powder and at once bottled up, using air-tight stoppers, or packed in lead lined wooden boxes.

PURIFICATION AND STANDARDISATION.

A pure product can be obtained from the latex or fresh juice itsel

It is prepared thus:—

20 grams of fresh juice is well stirred with 100 c. c. of 95 per cent. alcohol. A gummy white coagulum precipitates and is collected in a ball. The alcohol is poured off and replaced by 50 c. c. of the same strength. The papain readily crumbles to fine powder in a fine state during the second operation. It is then filtered, using the pump and washed twice with ether to remove semi-solid yellow wax and to facilitate drying. It is then dried in *vacuo*.

This gives a yield of 3 grams of papain. This is obtained in half-an-hour.—Indian Scientific Agriculturist, Vol. VI. No. 1.

YOUTH AND AGE IN PLANTS.

The majority of plants pursue the even tenor of their way from youth to age without vouchsafing to any but the most observant that they suffer from any of the "growing pains" incidental to the growing up of human youths. It is true that there is often to be seen a big break in the continuity between the germinating seed and the newly-established seedling. The first efforts of the seedling in the way of leaf formation are but feeble, and from them the scale leaves only result. With the vigour which comes to the establishment of independence the first rough leaf is formed, and often enough it is of mature form like unto all the leaves which will be produced thereafter. Another break of continuity which marks a tide in the affairs of plants may be observed when the plant becomes adolescent—ripe to flower. At this period also the flower-bearing branches, intent, as it were, on their business, all but forget that it is customary for a branch to bear leaves, and only produce perfunctorily, one or two mere rudiments of leaves which the botanist calls bracteoles or prophylls. Some Orders of plants, the Cruciferae, for example, give up the pretence altogether, and their flowering branches—without respect for the tradition that branches should bear leaves—produce their flower buds without any preliminary production of prophylls. The turnover from vegetative to flower-bearing state, which must undoubtedly be accompained by wide-spread change in the whole plant, takes place often with effortless ease. So smooth is the passage from vegetativeness to floriferousness that even now little or nothing is known of the inward change which leads to the outward grace of flowering. There are, however, plants which, as is well-known, take a long time to grow up—as measured by their flowering—and others which never grow up at all. The once flowering Palms, Agaves, and the like, which go on living and growing in leisurely fashion for long terms of years, then flower, fruit, and die, are instances of the former. Many New Zealand plants which have juvenile non-flowering forms and the Retinosporas—permanent, juvenile Conifers—are among the many well-known examples of the latter. What makes the once-flowering Palm at long last reach maturity, and what causes it to die when it has set its seeds, are alike unknown. Some say that the trees are worn out by the heavy work of seed and fruit production, but this is only an example of the all too frequent application of the obvious. It is more likely a case of plant suicide; and all the yearly deaths of annuals may well prove to be so many examples of self immolation in the interests of the race—"The

individual withers and the world grows more and more." There is much in the anatomy of herbs and herbaceous perennials to suggest that they are not the sort of stocks whence perennial trees evolved, but rather that they are degenerate members of races which once enjoyed the stature and status of long-lived and frequently-flowering trees. The world went very well then, in that far-off time when most Dicotyledons and Monocotyledons enjoyed, as is supposed on this hypothesis, a tree-like habit. But as climate evolved, becoming more unequal over the face of the earth, tree forms of vegetation were confined to the districts with constant water-supply; from the other areas, as trees, they were banished. Some "went out" for good and all, others began to take a lower place, until at last what was once a tree may now be the ephemeral and minute herb which springs up, matures, bears flowers and ripens seeds within the space of a few weeks. Any one who tends plants may observe signs—it may be slight, yet nevertheless sure, that fertility is not a mere inevitable event which ensues from lapse of time. An interesting instance of the peculiarity of the state of a plant with respect to flower bearing is described by Mr. L. B. Stewart in the case of a species of Gardenia. * A cutting from the main vertical stem of the plant goes on growing for twenty years or more without flowering, but if cuttings are taken from one of the side branches the plants which arise are of branching growth and flower regularly year by year. What they gain in floriferousness they lose in mere stability. For whereas the non-flowering, upright plants live on unflowered, the bushy, dwarfer plants which flower after a few years produce root suckers which, like a Rose stock overgrowing its scion, pushes up as an upright stem, that, unless removed, "sucks the verdure" out of the other, so that the bushy plant by its side ceases to flower and presently dies.—Gardeners' Chronicle, Vol. LXXVII. No. 1985.

BRAZIL NUTS.

An interesting account of the Brazil Nut industry of the region of the Amazon Valley is given in a Bulletin published by the United States Bureau of Foreign and Domestic Commerce and reviewed in the Journal of the Royal Society of Arts,† from which the following particulars are gleaned. Brazil Nuts are the fruit of a tree found almost exclusively in Brazil known as *Bertholletia excelsa*. This is one of the oldest trees of the South American jungles, and attains a height of some one hundred and fifty feet with a diameter of about six feet at the base of the trunk. The tree makes a characteristic growth, with a long, strong trunk furnished with branches only on its upper portion. It is stated that the production of Brazil Nuts in the State of Amazonia has increased very largely in recent years, and now slightly exceeds that of the State of Para, the former principal exporting country. The following figures show that there has been a great increase in the export of these nuts, for whereas in 1914 the total amount equalled

* Transactions and Proceedings of the Botanic Society of Edinburgh, XXIX., Part 1, 1924

† October 24, 1924.

329,934 hectolitres, each hectolitre equalling one cwt., the amount in 1922 was more than double, *i.e.*, 682,524 hectolitres, or, roughly 34,000 tons. As most of our readers are aware the nuts are enclosed in a very hard, outer case some half-inch in thickness, and the number of Brazils in each fruit is from twelve to twenty-two. A single tree will produce from five hundred to one thousand pounds of nuts, not including the weight of the large, outer shell. Harvesting begins generally in November and lasts until June, the greater part of the crop falling from January to March. In certain districts, however, the nuts begin to fall in November, and those from these regions are ready for market over a month in advance of those from other parts. This is stated to be an important advantage, as such nuts are available for the Christmas season, when they are most in demand and realise the highest prices. When the fruits drop they bury themselves in the soft soil, and searching for the fruits is accompanied by some risks, as gatherers have been, at times, fatally injured by the fruits falling on them from these high trees. In order to mitigate this danger a kind of hut made of thatched Palm, with a steep slope to the roof, is set in the middle of the forest area where the nuts are to be gathered. Opportunity is taken of the time when there is little or no wind to set out to gather the nuts already fallen. The work is done as quickly as possible, and the fruits are gathered in baskets and carried to the hut. When the wind is strong the gatherers remain in the hut, opening the outer shells by means of machetes and extracting the nuts. The latter are washed thoroughly to give them a clean appearance, conveyed to a neighbouring stream and transported by water to the nearest shipping centre. The proprietors of the interior sell the nuts to commission merchants who, in their turn, market them to the exporters. The market price is fixed by auction in Para and Manaos. The large, outer shell furnishes a kind of oakum used for caulking ships, while from the "Brazils" themselves oil is extracted, and this oil was only a few years ago extensively used in the Amazon Valley for illuminating purposes. The oil also contains medicinal properties, so that it has a pharmaceutical value. As to the timber of the tree, it is valuable for naval construction, but very little timber is produced, as the owners are disinclined to destroy trees which are such a valuable source of profit. Little effort has been made to cultivate *Bertholletia excelsa*, and although for the present the demand is fast outstripping the production, there are large areas yet to be exploited. The best customer is the United States, but large quantities of nuts are sent to Europe, by far the larger portion being consigned to this country.—Gardeners' Chronicle, Vol. LXXVI. No. 1983.

CAFFEINE FROM COFFEE LEAVES.

According to the *Philosophical Journal* the idea originated in Sumatra to extract the caffeine from coffee leaves and that this industry, which promises to develop in importance, has only been started since the war. The coffee leaves may only have been commercially exploited for the extraction of caffeine since the war but it has long been known that it exists plentifully in the leaf. Although the Sumatrians appear to have been the first to discover

the process of extraction they were by no means the first to entertain the idea as it was a matter of discussion in England "scientific journals" over a quarter of a century ago. Although as yet the process has been kept secret it cannot for long remain so, as there appears to be no gainsaying the purity of the product. In Sumatra the coffee berry is not much used as a beverage, all being reserved for export but we are told that an infusion of the torrefied leaves are much used and that the use of the leaves for this purpose has grown to such an extent as now to be looked upon as an absolute necessity of life. Germany of late years appears to have been importing enormous quantities of coffee leaves from Sumatra and utilizing them in the same way and in some parts of Germany the coffee leaf infusion has quite taken the place of the berry. This coffee leaf trade has been going on for several years and rapidly increasing, and it is somewhat strange that we have heard little or nothing about it until recently. Research work has proved that the extract obtained from the leaves has undoubted nutritive properties, and a vast number of analyses have furnished data guaranteeing its safety as an article of diet with an entire absence of deleterious effects. The use of the infusion appears to have been long known to the natives of Sumatra who use it along with their daily food of boiled rice. It is now suggested that although the coffee berry cannot be grown profitably upon all soils and elevations the bush will grow luxuriantly upon nearly all kinds of fertile soils at low elevations in any tropical country and consequently the field for the production of leaves is almost unlimited. Queensland is a comparatively new coffee growing country but the coffee planters there have already shipped samples of their leaves to Hamburg where they have been favourably reported upon. The odour of the leaves is described as exceedingly fragrant and something like a mixture of tea and coffee. The infusion in boiling water produces a transparent dark-amber coloured liquor which, used in the same way as ordinary coffee with the addition of milk and sugar, is said to be excellent. Nothing is said about cost of the article further than that it is a cheaper beverage than coffee.—Mysore Economic Journal, Vol. II. No. 1.

CITRONELLAL ASSAY.

Citronella oil is the principal raw material from which geraniol and citronellal are obtained. There are two varieties on the market, Ceylon oil and Dutch East Indian citronella oil, the latter containing a higher proportion of citronellal than the former. In view of the fact that hydroxy-citronellal is one of the most extensively used synthetic perfumes, it is important to establish the amount of citronellal present in the raw material employed for its manufacture, and for this purpose the customary geraniol content test is not a reliable index. To remedy this defect, J. Dupont and L. Labaune ("Chimie et Industrie," August 1924) propose a method of assay of citronella oil, which is based on the following considerations: on boiling for two hours a mixture of geraniol, citronellal, acetic anhydride and dried sodium acetate a mixture of geranyl acetate and isopulegol acetate is obtained. On titrating the esters present in the mixture the total amount of geraniol and citronellal can be ascertained. If now the citronellal is transformed into

citronellal oxime, and the mixture boiled for one hour with double its weight of acetic anhydride, the geraniol present is acetylated, while the citronellal oxime is transformed into citronellic nitrile. If the boiling mixture is now submitted to the action of alcoholic *N/2* solution of caustic soda, only the geranyl acetate is hydrolysed, while the citronellic nitrile undergoes no modification, hence only the content of geraniol in the mixture is ascertained and the difference between both results yields the amount of citronellal. The test, therefore, consists of two operations: (1) 10 grams of citronella oil, 10 grams of acetic anhydride, and 2 grams of dried sodium acetate are boiled for an hour and a half, and the total alcohol content determined by the customary method. This gives the total content of geraniol and citronellal present in the oil. (2) A solution of 10 grams of hydroxylamine hydrochloride in 25 grams of water is neutralized by the addition of a solution of 10 grams of sodium carbonate in 25 grams of water. This mixture is added to 10 grams of citronella oil, and whole warmed to 20°-25° for two hours, with agitation. The supernatant oil is removed by decantation, washed with water, dried and heated to ebullition for one hour after adding double its weight of acetic anhydride. The total alcohol content is then determined in the same way as for any essential oil. On substracting this figure from that obtained in the first test the result indicates the content of citronellal present in the oil.—Chemist and Druggist, Vol. C. I. No. 2344.

IMPERIAL BOTANICAL CONFERENCE, LONDON

The following three resolutions have been passed unanimously by the Imperial Botanical Conference which was held at London in July, 1924.

(1) "That this Conference, fully aware of the necessity for co-ordination of botanical work in all parts of the Empire and recognising that both investigators and undergraduates will benefit by contact with fresh points of view, urges that every effort be made to encourage the exchange both of members of the staff and of research students between the Universities and Research Institutions of the Empire, and recommends the establishment of a permanent Committee for this purpose."

(2) "That this Conference desires to call the attention of Overseas Governments to the great lack of scientific literature in some of their scientific institutions, and to urge them to remedy this defect where it exists."

(3) "That this Conference strongly urges the need for further facilities for research in Forest Pathology in all its aspects, and for closer co-operation between forest pathologists, executive forest officers, and other silviculturists."

CARBON-DIOXIDE AND INTENSIVE CULTIVATION.

Anyone possessing a knowledge of the rudiments of the physiology of plants would be disposed to believe that an increase in the amount of carbon-dioxide in the atmosphere may lead to an increase in crop-production This gas, which is the carbon-containing raw material used by the green plant in its synthesis of sugars, is present in the atmosphere in extremely small proportions (0·04%) relative to those of the other gases—oxygen and nitrogen—which make up the chief part of the atmosphere. Indeed, it was this consideration which delayed the general acceptance of the discovery made about a century ago that the green plant derives its carbon from atmospheric carbon-dioxide. When, however, the vastness of the atmosphere is considered, it becomes apparent that the supplies of carbon-dioxide which it contains are amply sufficient to provide all the vegetation of the earth with carbon. Yet, although this is so, the question still remains whether plants in Nature are able to obtain from the air about them all the carbon-dioxide they can use so quickly that there is no lag in the production of carbohydrates owing to delay of arrival in the leaves of fresh supplies of carbon dioxide. In order to investigate this problem, knowledge must be available both of the mode of absorption of carbon-dioxide and of the manufacturing process carried on by the green leaf. Thanks to the labours of plant physiologists, and particularly those of Horace Brown and Blackman in this country, it is known that the leaves with their multitudinous stomata are extremely efficient absorbers of carbon-dioxide : and it is also known that the rate of manufacture of carbohydrate by the green leaf depends on many factors of which temperature, light-intensity, and water-supply, together with supply of carbon-dioxide are the chief. Any one of these factors may limit the rate of the photosynthetic production of carbohydrate and, as Dr. Blackman has shown, if any one of these factors be in defect no increase in the others can augment the rate at which the process goes on. For example, if temperature be too low no increase in the light-intensity will speed up the process ; or if light-intensity be deficient no increase in the supply of carbon-dioxide will cause the photosynthetic process to go on any faster. Hence, from the point of view of the horticulturist of this country, the problem which is to be resolved is whether under the physical condition of light and heat which prevail here an artificial increase of the carbon-dioxide supply to the plant may produce an increase of crop production. Evidently this problem can best be attacked by studying it in those circumstances in which climatic and weather conditions are most under control. Glass-house cultivation manifestly affords the best example of such control. Water-supply and temperature may be regulated at will and, if need be, sunlight may be supplemented by artificial light. But unless there is to be a grave risk of disappointment it is necessary, before beginning actual attempts to increase crop production by means of augmented

supplies of carbon-dioxide, to ascertain the amount and distribution of carbon-dioxide in the air of glass-houses used for intensive cultivation. For instance, it is often claimed that in glass-houses the copious supplies of rich soil and manure liberate—owing to the activities of the micro-organisms which they contain—so much carbon-dioxide as to raise the percentage of that gas to many times that of the natural atmosphere. It has, indeed, been claimed that the concentration of carbon-dioxide in the layers of the air nearest to the ground is an important factor in the rapid growth of herbaceous plants. But if this concentration of carbon-dioxide in the air bathing the leaves of herbaceous plants is already high, it becomes doubtful whether raising it yet more will make any difference in the rate of photosynthesis. Nevertheless, it is a salutary rule of experimental science not to argue about what may or may not be, but to seek to learn truth by experiment. The first step in this process must be to ascertain whether there is a higher concentration of carbon-dioxide near the ground level. This investigation has recently been made with great care by Messrs. Owen and Williams at the Experiment Station, Cheshunt. The results of their Experiments* show that the opinion generally held that carbon-dioxide is stratified in the air is erroneous. They find that the concentration of carbon-dioxide in a greenhouse is erratic and does not occur in a regular manner. Incidentally it is of interest to note that the authors show that the concentration of this gas varies during the twenty-four hours, rising to a maximum in the early morning and falling to a minimum in early afternoon. It would thus appear that the plant tends to deplete the air of this gas during the period of its photosynthetic activity, and that when this activity ceases, as it does with the closure of the stomata in the early afternoon, the supplies of carbon-dioxide in the neighbourhood of the plant increase again, in part, at least because of the production of this gas by the respiration by the green plant. The next step in the investigation, which has already been taken by Messrs. Owen and Williams, is to discover how to produce and maintain a higher atmospheric concentration of carbon-dioxide than that which is usually present. The technical difficulties proved serious, but after essaying various methods the authors have contrived one which enables them to maintain the carbon-dioxide contents of the air at any desired concentration—or, at all events, between two known concentrations. In order to do this they produce rapidly large quantities of carbon-dioxide by the action of sulphuric acid on bicarbonate of soda and distribute it by means of an electric fan. These preliminary investigations may seem tedious to those who want to know definitely one way or the other whether carbon-dioxide is to be added to the list of artificial fertilisers. Those, however, who are possessed of this desire, must perforce exercise patience until the results of experiment are known. They may console themselves with the reflection that the result—whatever they prove to be—will be more convincing now that these preliminary enquiries have paved the way for really crucial experiment. For our part, we appreciate and admire the thoroughness with which the authors are attacking a problem which, if solved once for all, may prove the means either of saving useless expense or of bringing about a large increase of crop production, at all events, under glass-house conditions.—Gardeners' Chronicle, Vol. LXXV. No. 1943.

* *The Annals of Applied Biology*, x., 3 and 4. December, 1923.

MARKET RATES.

MARKET RATES FOR SOME CEYLON PRODUCTS.

(FROM THE CEYLON CHAMBER OF COMMERCE WEEKLY PRICE CURRENT, DATED 9th FEBRUARY, 1925.)

NAME OF PRODUCE		CURRENT PRICE			REMARKS
		Rs. cts.	at	Rs. cts.	
CACAO—(At Buyer's Stores)					
Estate—Finest	per cwt.	50 00	,,	56 00	
Do Medium	do	38 00	,,	54 00	
Do Common (Black)	do	15 00	,,	30 00	
CARDAMOMS					
All round parcel well bleached	per lb.	... ...	,,	... ...	
Do do medium	do	3 35	,,	3 80	
Special assortment 0 & 1 only	do	... ...	,,	... ...	
Seeds	do	3 80	,,	4 00	
Green	do	3 50	,,	3 80	
CINNAMON QUILLS—(At Buyer's Stores)					
Ordinary assortment (in bales of 100 lb. nett)	per lb.	0 81	,,	0 87	
No. 1	do	0 84	,,	0 90	
No. 2	do	0 82	,,	0 89	
No. 3	do	0 79	,,	0 87	
No. 4	do	0 75	,,	0 83	
CINNAMON CHIPS—Maradana, (At Buyer's Stores) (in bags of 56 lb. nett) per candy of 560 lb.		75 00	,,	85 00	
CITRONELLA OIL—(ex-Seller's Stores without packages) ...	per lb.	1 85	,,	1 95	
COCONUT—(Desiccated) Granulated goods (Delivered at Wharf or Buyer's Stores)					
Assortment: Medium 50 per cent. Fine 50 per cent. ...	per lb.	0 19	,,	0 19 3/4	
COCONUT OIL—					
White Oil f.o.b	per ton	... ...	,,	590 00	
Ordinary Oil do	do	... ...	,,	560 00	
COPRA—	No. 1 quality				
Calpentyn	per candy of 560 lb.	78 00	,,	83 50	
Estate	,, ,,				
Ordinary quality (Maravila)	,, ,,				
Cart Do do	,, ,,				
FIBRES—(At Buyer's Stores)					
Coconut Bristle No. 1	per cwt.	8 00	,,	10 00	
Do No. 2	do				
Coconut Mattress No. 1	do	2 30	,,	3 00	
Do No. 2	do				
Coir yarn, Kogalla Nos. 4 to 9	do	10 00	,,	25 00	
Do Colombo Nos. 3 to 7	do				

PLUMBAGO		X. B.			B.			B. E.		
		Rs. cts.		Rs. cts.	Rs. cts.		Rs. cts.	Rs. cts.		Rs. cts.
Ordinary Lumps ...	per ton	300 00	at	400 00	250 00	at	350 00	200 00	at	250 00
Chips ...	do	240 00	,,	325 00	200 00	,,	275 00	165 00	,,	225 00
Dust ...	do	175 00	,,	250 00	100 00	,,	175 00	60 00	,,	120 00
Do Flying ...	do	100 00	,,	145 00	75 00	,,	100 00	45 00	,,	65 00

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 28th FEBRUARY, 1925.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1925	Fresh Cases	Recoveries	Deaths	Balance Ill	No. Shot
Western	Rinderpest	58	37	27	22	—	9
	Foot-and-mouth disease	165	155	65	—	99	1
	Anthrax	—	—	—	—	—	—
Colombo Municipality	Rinderpest	—	—	—	—	—	—
	Foot-and mouth disease	190	124	188	2	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	2	1	—	2	—	—
Cattle Quarantine Station	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	12	12	12	—	—	—
	Anthrax	57	12	—	57	—	—
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	241	57	183	—	58	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	7	1	—	7	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	28	28	25	—	3	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest	Free					
	Foot-and-mouth disease						
	Anthrax						
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	394	360	394	—	—	—
	Anthrax	—	—	—	—	—	—
North-Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	43	40	33	10	—	—
	Anthrax	—	—	—	—	—	—
North-Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	309	134	261	—	48	—
	Anthrax	—	—	—	—	—	—
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	706	307	558	26	122	—
	Anthrax	—	—	—	—	—	—
Sabaragamuwa	Rinderpest	42	42	9	27	—	6
	Foot-and-mouth disease	50	27	28	—	22	—
	Anthrax	—	—	—	—	—	—

M. D. S. A. WIJAYANAYAKE,
for Acting Government Veterinary Surgeon.

Colombo, 13th March, 1925.

METEOROLOGICAL

FEBRUARY 1925.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of Cloud 0=Clear 10=overcast	Mean Wind Direction during Month	Daily Mean Velocity	Rainfall: Amount	Rainfall: No. of Rainy Days	Rainfall: Difference from Average
	°	°	%			Miles	Inches		Inches
Colombo Observatory	79·2	—0·6	78	5·1	NNW	87	7·02	8	+ 5·24
Puttalam	78·4	—0·2	75	3·0	NE	134	1·01	4	— 0·23
Mannar	79·9	—0·1	76	4·6	NE	195	3·33	6	+ 2·08
Jaffna	78·5	—0·5	74	4·9	E	84	4·68	5	+ 3·50
Trincomalee	80·4	+0·1	73	5·0	ENE	177	4·06	9	+ 2·00
Batticaloa	77·7	—0·9	83	4·4	NNE	184	11·93	10	+ 8·69
Hambantota	78·2	—0·9	79	4·0	ENE	325	1·26	6	— 0·17
Galle	78·7	—0·7	82	5·1	Var.	106	4·51	10	+ 1·72
Ratnapura	80·5	—0·5	78	5·2	—	—	4·91	11	+ 0·49
Anu'pura	77·4	—0·7	78	4·7	—	—	2·89	7	+ 1·38
Kurunegala	77·9	—0·1	72	5·1	—	—	3·40	5	+ 1·84
Kandy	74·8	—1·3	75	5·9	—	—	3·52	9	+ 1·31
Badulla	69·8	—1·2	80	5·2	—	—	3·10	10	+ 0·10
Diyatalawa	64·8	—0·8	72	6·4	—	—	2·07	7	— 0·36
Hakgala	57·6	—0·3	83	6·1	—	—	3·36	11	+ 0·21
N.' Eliya	57·1	—0·4	74	6·1	—	—	1·54	8	— 0·46

The rainfall map for February affords a very pretty example of the distribution that occurs over the hills and the surrounding low country in a month when there is not much general movement of air across the island, and the chief controlling factor is local circulation. Thus at Nuwara Eliya and a few neighbouring gauges the totals were less than a couple of inches, and below their own February averages: over the greater part of the hill country the totals were between two and five inches, but on the outer fringe of the hills, and in the low country at their base, there was an almost complete ring of stations that recorded more than five inches.

The biggest gap in this ring was toward the North-West, in which direction nothing over 5 inches has been reported between Kegalle (6·7) and Sacumbe (7·9). Such monsoonal movement as did exist, was naturally from the North-East, and most of the Eastern Province stations were above their average, with falls of from five to twelve inches.

As will be seen from the table, temperatures were on the whole below average. Nuwara Eliya minimum on the 6th was 29·6°, which is only two and a half degrees above the record (27·1) established there in 1914.

Amount of cloud and mean Wind Velocity were both above average. Humidity was about normal, with a slight tendency for the coast stations to be below average and the higher inland stations above it.

A. J. BAMFORD,
Supdt. Observatory